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SASKATCHEWAN RESEARCH COUNCIL

30TH ANNUAL REPORT 1976

THE RESEARCH COUNCIL ACT, 1965,
Clause 21, in part, directs that:

1. The Council shall on or before the last day of February in each year submit to the Lieutenant Governor in Council a report of its proceedings and transactions during the next preceding calendar year, which report shall contain such particulars as the Lieutenant Governor in Council may prescribe.

2. Every report shall forthwith be laid before the Legislative Assembly if then in session or, if it is not in session, within fifteen days after the opening of the next session.

Regina, February 18, 1977

TO THE HONOURABLE G. PORTEOUS

Lieutenant Governor of the
Province of Saskatchewan

MAY IT PLEASE YOUR HONOUR:

The undersigned presents herewith, for your consideration, the report of the Saskatchewan Research Council for the year ended December 31, 1976.

Respectfully submitted,

Norman Vickar, Chairman
Saskatchewan Research Council

PLEASE ADDRESS CORRESPONDENCE TO:

Saskatchewan Research Council
30 Campus Drive
Saskatoon, Saskatchewan
S7N 0X1

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MEMBERS OF THE SASKATCHEWAN RESEARCH COUNCIL

The Honourable Norman Vickar, Chairman
G. J. Gartner, Vice Chairman
D. Bock
D. Murray (Interim Secretary)
N. Bromberger
E. B. Campbell
B. M. Craig
J. E. Fletcher
L. Katz
A. Kavadas
R. E. Lloyd
K. J. McCallum
G. C. Mitchell
D. Pichler
J. E. Spencer
E. B. Tinker

EXECUTIVE OFFICERS OF THE COUNCIL'S STAFF

Director ..... T. P. Pepper
Administrative Officer ..... R. E. Melvin

Division Heads

Chemistry ..... E. M. Coxworth
Engineering ..... W. H. W. Husband
Geology ..... R. G. Arnold
Industrial Services ..... I. S. Evans
Physics Division ..... J. Maybank

PROCEEDINGS OF THE COUNCIL

Membership of the Council remained at 15 during 1976. The Act allows a maximum membership of 21.

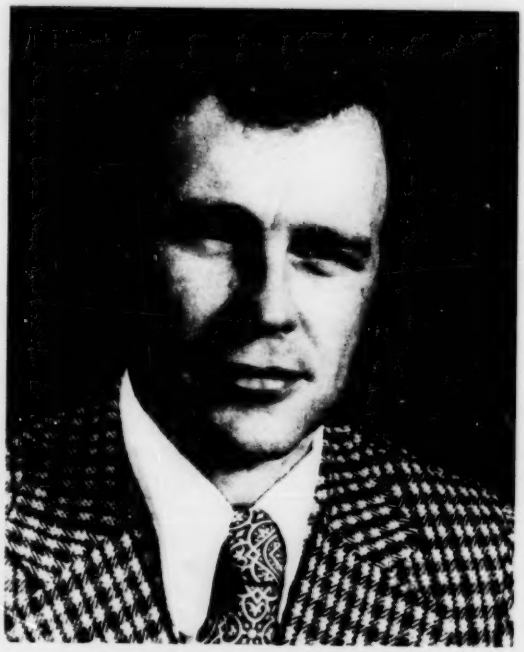
The Honourable Norman Vickar assumed the duties of minister-in-charge from the Honourable Jack Messer on November 10, 1976. Other changes included the expiration of terms of office of Dr. J. H. Archer and R. G. Dalgliesh and the addition to Council of Dr. E. B. Tinker and Mr. J. E. Spencer. Mr. R. Lloyd was reappointed to Council. Grateful thanks are extended to the retiring members.

To date, November 28, 1976, Council has met four times during the year: in Regina on February 9, February 25 and August 16, and in Saskatoon on May 17. The main business of these meetings was to receive the reports of the Executive Committee, to formulate policy and priorities for the program of the laboratories, to approve the 1976-77 program, and to recommend the 1977-78 program. Priority was given to strengthening the management of the Council to enable it to expand the activities of the laboratories for stimulating Saskatchewan's economic growth.

The Executive Committee consisting of the chairman, vice-chairman, secretary and Dr. B. Craig with the director acting as secretary, has to date met eight times since the last Annual Report, on November 28, 1975, January 15, March 18, April 27, June 16, August 5, September 29 and December 6, 1976. The main activities of the Executive Committee were to deal with routine administrative matters of the laboratories and, in conjunction with Council management, to prepare laboratory program details for discussion by Council.

1976 IN REVIEW

Change and challenge characterized the program of the Saskatchewan Research Council during 1976. In response to changing needs, special emphasis was given to the management and performance of Environmental Impact Assessments for both the private and public sectors. A modest beginning also was made to develop a managerial consulting service which would be a logical outcome of SRC's ongoing program. Challenges arose in trying to strike wise balances, in the Saskatchewan context, between short and long-range research projects and between undertakings in the general interest of Saskatchewan and fee-for-service work for specific clients.



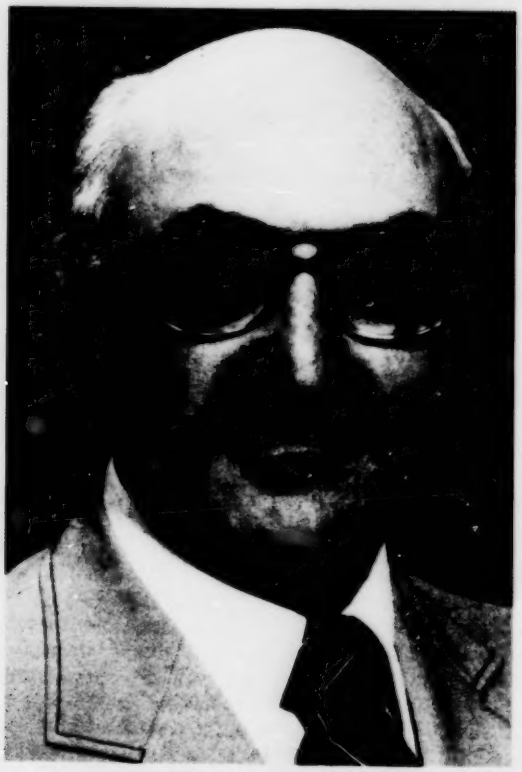
THE HONORABLE JACK MESSER
Past Council Chairman.

The program was tailored to meet the following goals:

— to undertake studies on how best to utilize Saskatchewan's resources, with emphasis on agriculture and agricultural processing.

— to promote the industrialization of Saskatchewan, with emphasis on in-Province upgrading of the Province's primary resources.

— to undertake environmental studies that contribute to the above and that also help preserve or improve Saskatchewan's environment.



THE HONORABLE NORMAN VICKAR
Chairman of the
Saskatchewan Research Council.

The year's activities are summarized therefore, under the headings of:

- Agriculture and Agricultural Processing
- Resource Development
- Industrialization
- Environment
- Services.

Agriculture and Agricultural Processing

SRC recognizes the continued importance of

agriculture to the Saskatchewan economy, the stabilizing effect of diversifying the industry and of encouraging industrial development based on agricultural products. The Council was involved in 10 projects associated with agriculture, the majority of which received funding from one or more interested outside agencies.

The high cost of feed grain continued to limit severely the potential for the beef cattle industry. The efforts of SRC, and other Saskatchewan-based agencies, to improve the feeding value of straw, continued at a high level and attracted nation-wide attention. Funding was by the Saskatchewan Department of Agriculture. Several methods were studied. The most advanced method is the use of ammonia to improve digestibility. This method will be ready for commercial and farm use in the fall of 1977. An alternative approach, involving steam treatment of straw is ready for animal trials. A third approach is under study in which naturally occurring microorganisms do the job of rendering the straw more digestible. Selected white rot fungi are being used. If successful, this approach might be appropriate for use on farms, feedlots, or at regional processing centres.

There are hundreds of thousands of tons of waste flax fibre produced annually in western Canada's flax seed crop. Need the fibre be a waste product, or can it be used in paper or linen? SRC is coordinating the efforts of several agencies in exploring the best commercial use of flax seed fibre.

A new project in 1976, supported in part by the Federal Department of the Environment, was a study of the concentration and movement of grain dust resulting from the large-scale grain handling in Saskatchewan's elevator system. As a result of this preliminary study, the SRC expects to be involved in the non-medical aspects of a co-operative program to study the possible disease hazards of dust in grain handling.

Other continuing agricultural projects include:

- The development of new animal feeds with increased nutritive value from alfalfa and leaf proteins;
- The desalinating of brackish water for community and feedlot operations;
- Providing technical and economic information for controlling feedlot runoff;
- Studying ways of increasing water supplies from farm wells;
- Pesticide spray drift studies;
- Maintaining an alert to weather modification practices, that is hail reduction and rain augmentation, in Alberta and North Dakota to note any downwind effects in Saskatchewan.

TWINBOOM SPRAYER specially designed for use in pesticide spray drift trials to compare simultaneously different application techniques.

Resource Development

Reflecting a continued interest in applying technology to the development of Saskatchewan's renewable and non-renewable resources, SRC engaged in over a dozen projects in resource development during 1976. Amongst non-renewable resources, emphasis was placed on developing and exploiting methods of locating economic mineralization, especially uranium, and in conducting a detailed inventory study of Saskatchewan's lignite coal. A major project involving the use of solar energy was commenced, illustrating a special interest in renewable resources.

The Precambrian region of northern Saskatchewan is rich in deposits of uranium, lead, copper and zinc. One relatively inexpensive method of exploring for these deposits employs geochemistry.

FLIGHT-AUGER SAMPLING of near-surface sediments is employed in geology studies in all parts of Saskatchewan, including the north.

Geochemical mapping of the occurrence and concentration of these economic metals provides a guide for more detailed but more expensive geophysical exploration methods.

The SRC engaged in a number of geochemical projects during the year.

The field program was devoted to taking samples from lakes whose sediments showed unusually high concentrations of uranium, copper, zinc and arsenic. Over 3,800 samples were taken, revealing unusually high concentration of uranium in 51 cases, of copper in 25 cases, of zinc in 4 cases and of arsenic in 10 cases. This technique is capable of identifying broad trends of above average mineralization which can lead to the discovery of economic ore bodies.

Measurements of the direction of GLACIAL STRIAE give insight into the pleistocene history of northern Saskatchewan.

While glacial deposits overlying mineral-rich Precambrian rock often are obstacles, the application of geochemical techniques may make these same deposits useful. Indication of the location of ores in the parent rock may be deduced by sampling the glacial deposits and mapping the concentration of minerals found therein. An SRC program sampled glacial material over bedrock at 610 sites. An area of over 100,000 square kilometres has been covered to date and the results have been summarized on 1:250,000 scale maps. The program was funded by DREE under a Federal-Provincial agreement.

The rich ore deposits of Flin Flon lie in volcanic rock that stretches from Amisk Lake in Saskatchewan eastward into Manitoba. Using geochemical techniques some 260 square kilometres of the volcanic terrain have been mapped, and a number of promising areas have been identified for further exploration.

A worldwide uranium shortage may develop within a decade. Uranium occurrences at Rabbit Lake, Cluff Lake, and Key Lake indicate that the geological conditions are favourable for further economic discoveries in Saskatchewan. A project, in co-operation with the Saskatchewan Department of Mineral Resources, investigates the origins of the above-mentioned deposits. The study aims first to understand the environment of the deposits, and then, to apply geological and geochemical techniques for recognizing other favourable areas.

FUTURE LIGNITE STRIP MINING SITES, such as this one near Estevan, will be defined by a cooperative lignite coal resources evaluation program involving DMR, EM&R and SRC.

The major program of resource development in the south was the continued evaluation of Saskatchewan's lignite coal resources (a co-operative program involving SRC, the Saskatchewan Department of Mineral Resources and the Federal Department of Energy, Mines and Resources). Drilling was conducted at some 500 sites, providing 4,500 samples. The geological, geophysical and chemical information so obtained was then computerized to enable technical and economic evaluations. The results will be presented in a report and an atlas of maps.

Development of renewable resources has received SRC attention through the management of the design and construction of a Provincial Energy and Resource Conservation Demonstration Home. The project was undertaken for the Saskatchewan Energy Secretariat and the Saskatchewan Housing Corporation. This home is to demonstrate the practical application of solar energy, to emphasize energy conservation measures, and to make all practical uses of Saskatchewan products in its construction. The home is scheduled to be opened to the public in the fall of 1977.

Industrialization

In some 20 projects, SRC continued efforts to assist existing Saskatchewan industry, stimulate industrial diversification and, in particular, encourage those industrial activities involved in upgrading Saskatchewan's primary resources of agriculture and minerals. Managerial consulting received specific emphasis with the introduction of Management Services.

Under a contract, the SRC administers NRC's Technical Information Service (TIS). This contract consists of a Technical Inquiry Service and an Industrial Engineering Service, both offered to Saskatchewan industry by SRC staff on a free and confidential basis.

Under the Technical Inquiry Service, backed with the expertise and information-handling facilities of the Canadian Institute of Scientific and Technical Information (CISTI) of NRC, SRC staff makes itself available to Saskatchewan manufacturers, process and extractive industries to provide technical information, advice, and guidance on technical problems. During the year, 360 calls were made and assistance offered on diverse subjects ranging from the measurement of noise levels, to the selection of a grinding machine. The Technical Inquiry Service published the *Catalyst*, a bulletin with circulation of over 4,000, discussing such technical topics as "Energy Conservation", "Striving for Efficiency", etc.

The complementary service, Industrial Engineering Service, concentrates on improving the effectiveness of any aspect of a small firm's operations by improving productivity, reducing costs or increasing sales. The service also publishes *Industrial Business Management* (a bulletin with circulation of 3,000) which contains such topics as "Industrial Product Design" and "Productivity and Profits".

The Council was host to the ANNUAL NRC-TIS CONFERENCE at Moose Mountain Provincial Park, September 13-17, 1976.

SRC was honoured this year to host the annual NRC-TIS conference. Staff are preparing a report of conference findings on this year's topic *Designing the Future of TIS*.

A welding improvement program, initiated last year, and supported by the NRC and the Canadian Welding and Development Institute, generated a productive year. Some 70 metallurgical problems were attended to during the year, of which approximately 50% involved welding. Assistance was provided in a wide range of problems, from the failure of a bucket elevator chain, to welding defects in a pipeline.

A significant step was taken during the year to implement Council's wishes to increase Management Services to both the private and public sectors. Three full-time staff members presently are assigned to this activity. Projects, undertaken on a fee-for-service basis, include:

- Co-ordinating a multi-agency program to convert flax fibre from a waste to a saleable by-product of the flax seed industry.
- Improving a small company's productivity under PEP (Productivity Enhancement Project), a support program of the federal Department of Industry, Trade and Commerce.

Two of SRC's projects to exploit Saskatchewan's industrial minerals involved magnesium — a metal in high demand.

Under a contract with the Provincial Department of Industry and Commerce, a study was commenced to determine the feasibility of recovering magnesium salts from Saskatchewan ores.

Big Quill Lake contains some 10 million tons of magnesium sulphate. With funding from Saskatchewan Minerals and the federal Department of Energy, Mines and Resources, SRC continued an experiment to concentrate this magnesium sulphate by using the spray-freeze technique developed for water desalinating. The results look promising.

Other undertakings, involving industrial minerals, include contractual assistance to Saskatchewan's sodium sulphate industry, investigating the possibility of making ladle brick from Estevan area stoneware clays, and looking into possible uses of Saskatchewan clays for whiteware manufacture and for artware.

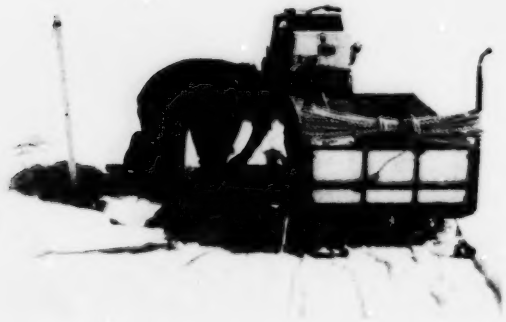
Transportation is an important factor for industrialization in Saskatchewan. This year, SRC

engaged in several studies covering a wide range of transportation problems.

A HIGHWAY TEST TRACK, unique in Canada, will permit accelerated pavement testing with full, year-round environmental control.

Under contract from the Saskatchewan Department of Highways and Transportation, SRC is supervising the design and construction of a highway test track.

The same Department continued its contract with SRC for the study of ice bridges across rivers and lakes in winter when ferries are inoperative. The study was continued at Riverhurst on the South Saskatchewan. Results and subsequent theoretical studies were published and have attracted international attention.



TAKING THICKNESS MEASUREMENTS at Riverhurst, in order to obtain data for the design of ice bridges.

Finally, SRC's slurry pipeline facility was kept busy with contracts from various clients to study: the transport of coal in crude oil pipelines; and the pipelining of coarse metallurgical coal, salt, mine tailings and brines.

Environment

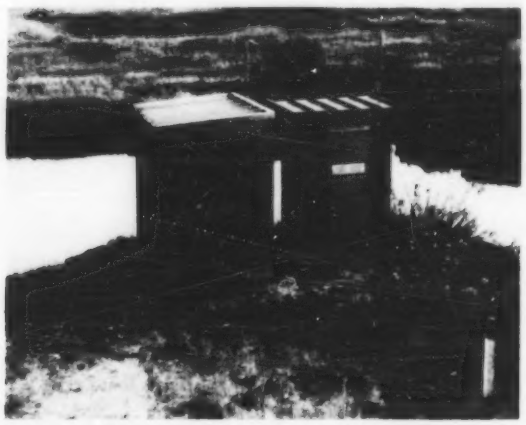
Environmental studies were the subject of 30 projects during the year, more than in any of the other major activity areas. A special effort was made to perform Environmental Impact Assessments under contract.

COLLECTING AQUATIC INSECTS with a Surber Sampler for a study of aquatic ecology of the Saskatchewan River near Nipawin.

Most of the studies of environmental impact were associated with Saskatchewan's energy resources. These studies included the work for the Saskatchewan uranium industry: an overview environmental assessment of a winter road for the Key Lake uranium mine development; an environmental overview of a proposed water level increase in the White Lake Power Reservoir north of Uranium City; and some preliminary environmental considerations with regard to the proposed uranium processing plant of Eldorado Nuclear Ltd. In addition, considerable environmental work was undertaken for SPC. SRC is providing background studies on five sectors of the Environmental Impact Assessment on SPC's proposed hydro-generating plant at Nipawin. SRC assisted also in dealing with the groundwater problems associated with strip mining of the lignite coal for SPC's proposed hydro-generating plant on the Poplar River.

SRC undertook two environmental projects for the Department of Northern Saskatchewan: a study of the impact of raising the water level of Cumberland Lake to improve trapping and fishing; and a study of a proposed road from Cumberland House to Amisk Lake.

A number of new environmental projects were commenced during the year.



THE SCHNEIDER ROBOT MONITOR samples water and records various measurements automatically. SRC maintains the monitor under a contract which provides specialized technical support for the Saskatchewan Department of Environment.

How can we deal with the increasing amounts of aqueous waste products? One novel way in which SRC is tackling this challenge is to exploit how certain aquatic plants absorb nutrients, heavy metals, toxic chemicals, and even mercury from municipal, industrial and agricultural wastewaters. SRC is conducting growth chamber trials. Preliminary results indicate that, when using raw sewage, the plants seemed more digestible and had higher protein content than similar plants grown in fresh water. The study is continuing to evaluate the effectiveness using effluents from feedlots, small industries, and rural communities. If successful, this technique would be acceptable economically, aesthetically and ecologically in many applications.

For efficient potash mining, two questions must be resolved:

- How much potash can be safely mined?
- What is the optimum geometry for maximum extraction?

SRC has continued its program of monitoring the build-up of stress in Cominco's mine. A contract was accepted from the Saskatchewan Department of Mineral Resources (DMR) to design and build a Creep Test Laboratory so that DMR can conduct control studies of how potash, from the various Saskatchewan mines, will behave under various stress conditions produced in mining. The special instrumentation required for this facility is expected to be operational by March 1977.

Two new climatological projects were started in 1976.

This unusual, early spring, HAIL STORM was part of the climatic data recorded by SRC in Saskatoon.

One project involved the production of a multicolor map at a scale of 1:1,500,000 (for more than 50 stations in the arable portion of Saskatchewan), showing such climatic factors as monthly and annual precipitation, mean annual snowfall, and frost-free season data. The other project, under contract from Environment Canada, is a paleo-climatological study of factors affecting the water balance of Canadian lakes since the last glaciation some 12,000 years ago.

Additional new projects include:

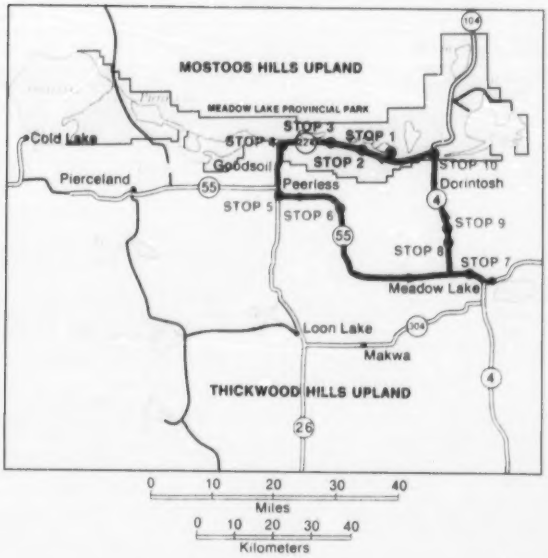
- A study, under contract with the Department of Mineral Resources, of the brine pond dikes of the potash mines;
- The production of the Fort Qu'Appelle Geolog, *i.e.* a booklet portraying for the public the environmental features of a 65-mile road tour of 11 stations around Fort Qu'Appelle;
- Climatic input for a grasshopper study with Agriculture Canada;
- A study of the dynamics of snow deposition and inclusion in the fresh air intake of the Education Building of the University of Saskatchewan.

Continuing environmental studies included:

— the environmental effects of clear cutting

— minimizing surface water pollution from agriculture
— the value of sloughs and potholes
— prediction of runoff from small drainage basins
— compilation of glacial geologic data between 49 - 58 N
— collecting and computing data from the Saskatchewan observation well network.

LOCATION MAP



The location map for the MEADOW LAKE GEOLOG guides visitors to the major physical features of the Meadow Lake Provincial Park area.

Services

Each Council Division provides some service to be used by all Divisions. These services include general shops, precision instrument lab, electronics lab, chemical and radiochemical analytical labs, tritium and carbon dating facility, cartographic and drafting units, a photographic lab, library and information retrieval service. No other Saskatchewan-based applied research agency has available an equivalent roster of service facilities. These facilities enable the multidisciplinary scientific staff to undertake a broad range of laboratory and field projects.

There was a significant increase in the amount of service work offered to outside clients this year.

The chemical analytical labs increased service contracts for outside clients by 40%. Major clients included the sodium sulphate, potash, and uranium industries. The radiochemical laboratory is now one of the most up-to-date in Canada. The carbon dating lab analyzed some 190 samples, approximately half under a contract with the Archaeological Survey of the Canada Museum of Man.

THE CHEMICAL ANALYTICAL LABORATORY has increased revenue by 40% over last year, primarily due to increased efficiency.

THE ELECTRONICS LABORATORY provides specialized support both within SRC and to outside agencies in government, university and industry.

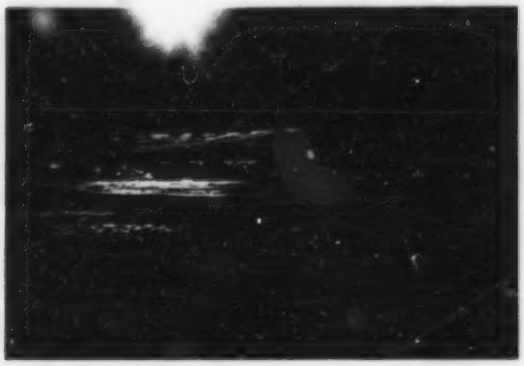
The electronics lab provided service to SPC, the Saskatchewan Department of Highways and Transportation, various University Departments, Intercontinental Packers, and Mercury Printers. The lab acquired a microcomputer development system so that microcomputer techniques could be used in the development of controller and data acquisition systems for clients.

The precision instrument laboratory, for the first time, performed more work for outside clients this year than for SRC Divisions. This lab modified the design of rotary fushion burners for uranium sample preparation and built five burners for customers in Canada, the U.S. and Europe. The lab sold a number of standard water level recorders to customers and undertook, for an engineering firm, a major modification which converted a standard recorder into a recording piezometer for water level measurements.

The cartographic and drafting units prepared and published maps for the Geology Division, maintained a library of cartographic and base maps, aerial photographs, mosaics, and E-logs. The unit frequently was consulted on modern cartographic techniques and is contracted by SDH&T to assist in the production of the 1977 Provincial road map.

SRC served applied research at the Universities by providing 16 grants totalling $82,000.

CARTOGRAPHIC UNIT STAFF provide in-plant supervision of lithography to maintain high quality publication standards.



CONTROLLED ICE BRIDGES maintain transportation and communications for communities, during the winter, which are served by ferries during the summer.

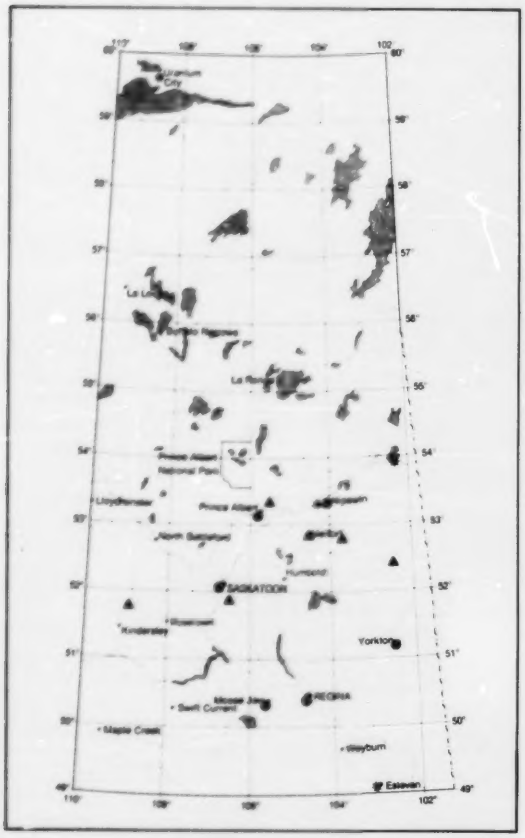
PROGRAM OF THE COUNCIL'S STAFF

REPORT OF THE CHEMISTRY DIVISION

Ewen Coxworth, Head

INTRODUCTION

The activities of the Chemistry Division are divided into three groups: 1. applied research and development, concentrated this last year in the topic area of renewable resources, 2. analytical services, including both routine analyses and the development of new and improved techniques for analysis, and 3. environmental impact studies, to provide information about the probable effects on the environment of proposed major developments such as mines and hydroelectric dams. Each group involves 6-9 people. Considering the nature of the activities of the three groups, a more apt title for the Division might be: Chemistry, Biology, and Related Environmental Studies.



EXPLANATION

- ▲ Applied Research and Development
- • Environmental Impact Studies
- • Analytical Services covers the entire Province. Some areas of activity cannot be listed because the geographic location would identify the client, thus withdrawing confidentiality.

Much of the applied research is being done in cooperation with the University of Saskatchewan, several Research Stations of Agriculture Canada, and most recently, with the Prairie Regional Laboratory of the National Research Council. Cooperative projects of this type seem likely to be a continuing feature of the research activities. The environmental impact study group also is involved on a number of occasions in cooperative programs with other organizations and individuals.

Processing Straw and Other Low Quality Forages to Improve Their Feeding Value for Cattle

Studies on chemical methods to improve the feeding value of straw involve collaborative research among SRC, the University of Saskatchewan and Agriculture Canada. Considerable financial assistance has been provided from the Horned Cattle Trust Fund, administered by the Saskatchewan Department of Agriculture.

As mentioned in the previous annual report, three simple chemical methods are being evaluated:

1. Stacks of straw, sealed in plastic tents, are treated with ammonia. Ammonia, from a commercial source, is pumped into the stack through a long perforated pipe and the treated straw is kept in the gas sealed tent for several weeks. The bag is opened carefully and any excess ammonia is removed by aeration. The treated straw now is ready for feeding.
2. Chopped straw, sprayed with a concentrated solution of sodium hydroxide, is mixed and steam pelleted in a commercial pelleting mill.

3. Chopped straw is sprayed with a dilute solution of sodium and calcium hydroxides and stored with exclusion of air for at least one week.

Between 40 and 50 tons of straw were processed in the fall of 1975 by each of the three methods. The treated straw was fed as 60% of the growing ration of calves in a feeding trial conducted at the university feedlot. These diets were compared to a control diet containing 60% good quality brome-alfalfa hay.

The overall results of the trial indicated that ammoniation gave the most promise as a method to improve the feeding value of straw. Based on an ammoniation cost of $12-17 per ton, animals fed ammoniated wheat straw were only slightly more expensive to feed to market weight than animals fed good quality brome-alfalfa hay. One important observation was that physical form of the treated straw significantly affected animal performance. Thus, animals fed ground and pelleted ammoniated straw ate more and gained weight faster than animals fed chopped ammoniated straw.

Ammoniated wheat straw also was evaluated as a major component of the winter maintenance diet of pregnant cows. This straw could constitute as much as 85-90% of their diet, provided three pounds per day of rolled barley grain was included. Calving performance almost was comparable to that for animals fed on all hay diet.

Further reproductive performance data is needed before drawing conclusions about the value of ammoniated straw for pregnant animals.

More large scale feeding trials have been commenced to give more information on the ammoniation method prior to commercial application. These experiments will study the effect of physical form of the straw on the animal performance, and compare treated barley straw with treated wheat straw.

In addition to these two experiments, three farm demonstration trials on the ammoniation of straw have been started in different parts of the Province. The objectives of these three trials are to gain practical field experience of the ammoniation method and to obtain farmer's assessment of the material under actual farm conditions.

Other factors being investigated in the study include the effect of the variety of straw, the stage of maturity of the straw, the minimum concentration of ammonia required to improve the feeding value, the best methods to conduct the ammoniation in large scale stacks of straw. A comparison is being made of the use of high pressure steam with ammonia as an agent to improve the digestibility.

Fungal Fermentation of Straw

The use of naturally occurring microorganisms to improve the feeding value of straw would be an alternative to using chemicals.

The method under investigation involves treatment of straw (or wood) with selected white rot fungi, which degrade lignin much faster than cellulose or hemicellulose. This method shows promise of being free of the need for chemicals, fossil fuel energy, or expensive equipment.

While the initiative for testing this approach came from SRC, the project has been organized as a cooperative effort among several organizations. The initial laboratory evaluation of the microorganisms is being conducted by the Microbiology Section of the Prairie Regional Laboratory of the National Research Council. SRC will be involved in testing the products of the fungal fermentation, comparing them with similar products made by the ammoniation of straw, and collaborating in developing simple fermentation systems for use on farms, in feedlots, or in regional processing centers (for example, in conjunction with an alfalfa processing plant).

Processing Alfalfa to Increase Its Value as Animal Feed

Alfalfa is a high quality forage, in contrast to poor quality substances such as straw. The objective is the separation from alfalfa of a high protein content fraction, with reduced fibre content, which would be suitable as a protein source for monogastric animals.

The simplest approach was considered to be a leaf-stem separation of dried alfalfa. The leaf enriched fractions, from various alfalfa materials, were fed to growing pigs in trials conducted by the Animal and Poultry Science Department of the University of Saskatchewan. Dehydrated or air dried alfalfa, cut at the prebloom stage, gave the leaf fractions with the highest protein digestibilities. Cut at a later stage of maturity, alfalfa has a lower protein digestibility. Pelleting and regrinding did not improve the digestibility of the leaf fraction from dehydrated, early maturity alfalfa. The dry matter digestibility of whole alfalfa (early maturity) was considerably less than the digestibility of the leaf fraction, probably reflecting the greater amount of fibre in the whole alfalfa.

Even the best material had a protein digestibility considerably less than that of conventional seed protein meals. If alfalfa was to become a significant source of protein for monogastric animals, then we would either have to find methods to improve protein digestibility in dried leaves, or produce a leaf protein concentrate (free of fibre), known from other studies to have better digestibility.

SRC arranged to bring Mr. Walter Bray, a leading world investigator of leaf protein, to discuss alfalfa processing with business and research people in

Saskatoon. His studies indicated that processing of alfalfa to produce a concentrate, prior to drying, would result in considerable energy savings and be more profitable to the industry.

Animal trials with rats will study the digestibility of leaf nutrient concentrate and alfalfa leaf fractions. These trials should provide information as to whether the low digestibility of protein in intact dried leaves is due to indigestible cell walls encasing the protein or whether it is due to the mere presence of alfalfa fibre. Several other approaches also will be investigated. Alfalfas with reduced saponin contents have been reported to be more digestible than alfalfas with high saponin contents. This finding will be checked with material (air dried whole alfalfa) grown locally by Agriculture Canada. Alfalfa meal leaf fraction from conventional alfalfa will be tested with and without a commercial enzyme product which has been claimed to improve fibre digestion and protein utilization in monogastric animals.

The Effect of Various Organic Soil Amendments on Crop Production on Soils Affected by Salinity

In recent years, there has been a serious increase in the amount of soil affected by salinity, causing reduction in crop production. The main thrust of research has been to find cropping practices which would halt the increase in salinity. In addition, practices would be used to rehabilitate lands already affected by increased salinity. For example, various organic soil amendments have shown promise in other studies.

Cattle manure was compared with a number of organic materials as soil amendments to improve wheat production on soil affected by increased salinity. The other materials tested were straw, sod from slough edges, lignite coal, leonardites from three North American sources (leonardites are naturally oxidized lignite coals), and a commercial synthetic soil amendment. Manure very significantly improved wheat production. All other treatments had little or no effect. It was not possible, in these initial trials, to compare the effect of these treatments with or without added synthetic fertilizers. This comparison will be made in trials planned for next year.

Leather and Other Products from Hides

The project to produce soft, easily sewable leather for the handicraft industry has been completed. Leathers were produced by a relatively simple process, using glutaraldehyde as the tanning agent. Deerskin leathers, made by this method at a commercial tannery in Ontario, were sent for evaluation to various handicraft groups in Saskatchewan and Alberta. Responses were generally favorable and further development of this process is awaiting the decision of the handicraft groups.

SRC is continuing to act as consultant, on an informal basis, to a major food processing company. The pilot plant established by them is working satisfactorily, and patents and commercial production seem likely from the process being developed.

Renewable Energy Development and Energy Conservation

The Division is assisting the Engineering Division in its management of design and construction of Saskatchewan's Energy and Resource Conservation Demonstration House. Specifically, the Division is collecting data on similar projects and in designing and monitoring the solar energy collection system. This work is resulting in the acquisition of much useful information on renewable energy utilization systems which will be available to interested individuals and organizations in the province.

Analytical Laboratory

Although the number of personnel is the same, the billings for analytical services have increased approximately 40% over last year. Some of this gain was due to increased salary charges, however, much of the progression was the result of increased efficiency and output. The major areas of analytical service were for the sodium sulphate, potash and uranium industries, and for environmental monitoring and environmental baseline studies.

During the year, a low background flow-proportional counter has been acquired and put into operation (Tenelec LB-1000). This unit gives the added capability of performing the optimum method of Pb^{210} radiochemical analysis, as well as increased capacity for Ra^{226} and Po^{210} determinations. The radiochemical laboratory is one of the most up-to-date in Canada and is one of the few performing U, Th, Ra, Pb and Po analyses on a fee-for-service basis.

A new PDP 11/34 mini-computer presently is being installed with the aim of automating all data acquisition from laboratory instruments. This facility should give greatly increased throughput and reliability of analytical data, as well as automated printout of final analytical reports.

For the routine analysis of water samples, SRC acquired two new automated analyzers. This expansion will give separate channels for NO_3-NO_2 and PO_4 ions and greatly increase the throughput of these determinations. Many new analytical procedures in the areas of radiochemical determinations and trace metal analysis are under investigation and development and will be adopted for routine application if they are shown to provide improved reliability and performance.

The carbon dating facility continues to function at full capacity (approximately 190 samples per year). The laboratory is supported in part by SRC

and by the Archeological Survey of Canada, National Museum of Man. Approximately half the samples analyzed come from the Museum of Man, the rest are provided by a variety of organizations and individuals in Canada.

Studies on the Impact on the Environment of Industrial and Resource Developments

This year the environment impact studies group hired an archaeologist. The core group now consists of two senior biologists (terrestrial and aquatic biology), a junior biologist, an archaeologist, and three technical assistants. In addition, an environmental engineer has been hired, who occasionally will work on environmental assessment studies.

The group has concentrated on environmental impact studies under contract from government departments and private organizations.

The group is endeavouring, with considerable success, to become financially self sufficient. Consequently, little time has been available this year for applied research activities. However, one staff member spent some time working on a project with the Engineering Division involving the use of aquatic plants to effect tertiary treatment of waste waters.

Environmental impact studies were divided between several major projects and a number of smaller contracts.

Members of the ARCHAEOLOGICAL TEAM catalogue artifacts uncovered during an environmental study of the Saskatchewan River area near Nipawin.

In connection with a proposed dam and hydroelectric generation plant on the Saskatchewan River near Nipawin, a number of environmental impact studies were conducted for the Saskatchewan Power Corporation. These studies included:

- forestry and vegetation,
- aquatic ecology,
- the possible effects on transportation and recreation (in cooperation with the Engineering Division,
- an archaeological survey.

The archaeological survey recorded 112 archaeological sites and 56 find areas. At eight of the sites, excavations were conducted. The survey revealed two main centres of prehistoric occupation in the region. One occupation was two miles northwest of Codette, on the eastern edge of the river valley. This location was known as Neepoweewin (the Standing Place) because it is over 200 feet above the river and affords a wide view of the valley. The other major centre was located in the area around Thomson Island.

Apparently, these sites continued to be important Indian Camping areas into the historic period since all the trading posts in the region were located in their vicinity. Archaeological material and sites were identified. They ranged in age from, as early as, 8000 years ago to as recently as the 1700's. Due to the study area's position on the northern edge of the parkland, it yielded material characteristic of both northern and southern Saskatchewan. These findings indicate an unusually complex prehistorical record.

The following list gives some of the other activities in which the group has been engaged:

- An overview environmental assessment of a winter road for the Key Lake uranium mine development.
- An environmental overview of a proposed water level increase in the White Lake Power Reservoir, north of Uranium City.
- A study for the Department of Northern Saskatchewan on a proposal to raise the level of Cumberland Lake to improve trapping and fishing in the area.
- A study for the Department of Northern Saskatchewan on a proposed road from Cumberland House to Amisk Lake.

Other studies have been concerned with animal and plant surveys in northern Saskatchewan, limnology and fisheries in northern lakes, and limnology in small water bodies in southern Saskatchewan.

A brochure is being planned outlining the type of projects the group has undertaken.

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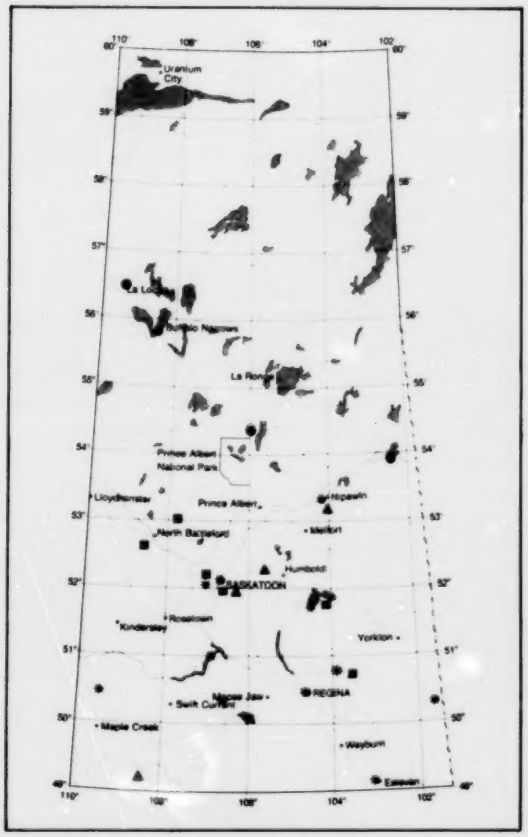
CHEMISTRY

REPORT OF THE ENGINEERING DIVISION

W. H. W. Husband, Head



EXPLANATION

- ▲ Water Desalinating Sites
- ■ Surface Water Test Sites
- • Contract Projects
- • Design of Water and Sewer Systems

Establishment of a Highway Test Track in Saskatchewan

Highway materials and constructional techniques pose a number of special problems in Saskatchewan, and there is a continuous need for improvement and development to meet the changing demands and economic factors. This process of development is slow; a new pavement design must first be installed as a test section on the public highway, then several years must elapse before useful conclusions can be drawn. There is an obvious need for a special test facility that will reproduce typical highway conditions in a controlled manner, and permit accelerated testing of new designs within a matter of months rather than years.

The Saskatchewan Department of Highways and Transportation (SDH&T) has contracted the Council to supervise the design, construction and commissioning of an indoor test facility with full environmental control.

A detailed design and costing exercise has been conducted by the Council over the last year. The final design and cost estimates have been accepted by SDH&T and permission has now been received to proceed with the construction phase.

Engineering Data for the Design of Ice Bridges

Several communities in Saskatchewan are situated close to ferries which have become an important part of their life-style and communications. These are seriously disabled when the ferries become inoperative during the winter months, and there is a growing demand for the establishment of controlled ice bridges to remedy the situation.

The SDH&T commissioned the Council to conduct an exploratory study on an ice crossing during the winter of 1974-75 with the aim of developing safe maintenance and operational procedures for provincial ice bridges generally. An ice bridge was constructed at Lake Diefenbaker, close to the line of the Riverhurst crossing. This was so successful that the bridge was reconstructed during the following winter and maintained and controlled on the basis of guidelines developed during the first year of operation.

The Riverhurst ice bridge was also used as a test site for the evaluation of a prototype radar unit which can measure ice thickness accurately, with great speed. These tests were commissioned also by SDH&T with the long term aim of establishing rapid ice thickness scanning programs for routine safety checks on several ice bridges.

The results of the Riverhurst study were published this year, and attracted considerable interest from within the Province and internationally. There is some indication that this study will result in further work along similar lines.

A Provincial Energy and Resource Conservation Demonstration Home

The Energy Crisis has given a powerful stimulus to the development of renewable sources of energy such as solar and wind. The most visible effect of this development can be seen in the many energy conservation and solar demonstration houses now springing up across Canada.

The Saskatchewan Government has been aware of the need for further research and development into renewable forms of energy and as a result has, through the Energy Secretariat and the Saskatchewan Housing Corporation, committed itself to funding the construction of an Energy Conservation and Solar Energy Demonstration Home. This house will be designed to emphasize the more sensible ways of saving energy at costs that the homeowner can reasonably afford. At the same time, it will act as a focal point and a source of information for those in the Province, either private homeowners or contractors, who wish to utilize energy-saving concepts in their homes.

The Council, calling upon all available expertise in the Province, has accepted the responsibility for identifying, assessing and recommending the best possible combination of energy-saving features that will be incorporated into the house.

When all the energy-saving features have been selected and optimised for cost, they will be given to an architect who will incorporate them in a design applicable to mass housing. The house will be open to the public in the fall of 1977.

Environmental Studies Related to Industrial, Agricultural and Public Utility Development

In 1976, the Saskatchewan Power Corporation (SPC) proposed the building of a dam on the South Saskatchewan River valley at Nipawin for the purpose of hydro-electric power generation. The reservoir created behind the dam would extend upstream from Nipawin, approximately to the Gronlid ferry crossing (25 river miles) and the rest would be confined within the steep banks of the river valley.

This development would irreversibly affect the environment of the Saskatchewan River valley between Nipawin and the Gronlid ferry crossing. Both SPC and the Saskatchewan Department of the Environment recognized that a number of environmental impact studies should be conducted, before proceeding with the building of the dam, to assess the environmental feasibility of the project. The Engineering Division obtained from SPC the contracts for the outdoor recreation study and the transportation study.

Both studies are designed in such a way that they will point out the negative and positive effects on the outdoor recreation and transportation conditions as presently exist in the Nipawin area, and recommendations will be made to mitigate undesirable effects in these two sectors. The studies were started in July of 1976 and the field work for the outdoor recreation study was completed in the fall. The final reports will be presented to the client, SPC, in June 1977.

Developing Methods to Recover Magnesium Chloride from Saskatchewan Ores

Under a contract with the Saskatchewan Department of Industry and Commerce and Saskatchewan Minerals, a study is underway to determine the feasiblity of several different processes for recovering magnesium salts from Saskatchewan ores. In addition, the optimum integration of each of these processes with energy resources available in the Province will be determined.

Saskatchewan has vast untapped reserves of magnesium salts from which high temperature magnesia refractories or magnesium metal and alloys could be manufactured. All are in demand in Canada and the world. Magnesium metal is expected to become a more important structural material because of its strength and light weight, factors which are important in a time of energy conservation. Saskatchewan has large reserves of relatively low cost energy which add further incentive to locate a magnesium chemicals industry in the Province. Such an industry would create many jobs.

During the current year, a detailed examination of process alternatives for the recovery of magnesium salts from Saskatchewan deposits has been nearly completed. This investigation will identify several attractive possibilities, and further studies will establish the salient features of each with respect to energy requirements. Future work will assess the most desirable means of satisfying these energy requirements.

The Potential of Aquatic Plants to Treat Waste Waters

There has been a renewed interest in the potential of natural biological systems in the control of water pollution as evidenced by the work of numerous investigators in Europe and the United States. Aquatic plants have been used to absorb nutrients, heavy metals, toxic chemicals and even mercury from municipal and industrial wastewaters. The technique is acceptable economically, aesthetically and ecologically in many places.

A study was undertaken in the early part of 1976 to evaluate the validity of the claims on the potential of aquatic plants, particularly under Saskatchewan's conditions of climate and ecology. Commonly occurring aquatic plants such as bulrush

(*Scirpus* spp.) and cattail (*Typha* spp.) were grown in a growth chamber measuring 18' x 11' x 12' high and fed with untreated raw sewage. The performance of plants was compared with that of the controls. The plants were periodically harvested and the biomass was subjected to *in vitro* digestibility analysis along with control plants from fresh water sloughs.

The results of the study showed that the plants reduced the level of nutrients such as phosphorus and nitrogen in the sewage by as much as 96 percent within 15 to 20 days.

Digestibility analysis has shown that the crude protein and digestible organic matter content of the harvested biomass are higher than fresh water plants and comparable with the high values obtainable from alfalfa and treated straw.

Design of Water and Sewer Systems for Northern Saskatchewan

The program of community development in northern Saskatchewan has raised a number of questions concerning the best and most suitable design of water and sewer installations. Present design exercises are being impeded by lack of design data for the conditions that exist in northern Saskatchewan.

A four-year program has been set up to provide the necessary data on the thermal interactions between soil and pipe installations. The program began in 1974 and is funded under a contract with the Department of Northern Saskatchewan.

The program is now entering its third year of operation. Instrumentation was installed around selected dwellings at La Loche, Weyakwin and Cumberland House in the fall of 1974. The installation at Buffalo Narrows was completed in the summer of 1975, as soon as the sanitary engineering work was complete. Since then, the policy has been to gather data steadily from all sites with a minimum of interference.

Chart records have been collected at intervals of about three months, and have been returned to the Council for tabulation and first stage analysis. There has been very little loss of data due to instrument failure, and the records from all sites virtually are complete. Bearing in mind the climatic variations from one year to the next, an absolute minimum of four years of study is required before the data begin to make sense.

Establishment of a Creep Test Laboratory for the Saskatchewan Department of Mineral Resources

The safety and economics of potash mines are dictated by the proportion of potash removed from the mined areas, and must be based on a thorough understanding of the physical processes occurring in and around the mined strata. Three factors are involved in the design of a successful mining operation:

1. A knowledge of the stresses in the potash pillars that support the overburden.
2. A knowledge of how the potash will behave under the application of these stresses.
3. The combination of these two factors in a rock mechanics theory that will predict the consequences of any proposed mining program.

The Council is already pursuing a supporting development program in connection with item (1), but the measured stresses will become meaningful only if there is a parallel study of potash behaviour under applied stress. Potash comes within the realm of 'soft rock mechanics' and deforms continuously under applied stress — a process known as creep. The creep behaviour of potash varies from mine to mine, and from point to point in the same mine. This calls for creep studies under a wide range of conditions, using large numbers of samples.

Consequently, the Saskatchewan Department of Mineral Resources has commissioned the Council to design and build a creep test laboratory. Potash samples will be tested, several at a time, in a precisely controlled environment. The size of these samples will require the design and construction of a special type of creep cell.

Potash mines in the Province are faced with the problem of how much potash to extract and how much to leave in place. If too much potash is extracted the remaining pillars will provide inadequate support for the overburden. If too little potash is extracted the mine is being operated wastefully and uneconomically. The staff of the various potash mines have to exercise judgement in designing their mining operations for the best balance of these two factors. Their task is made more difficult by a lack of information on the conditions that exist inside a typical potash pillar.

To remedy this situation the Council has initiated a program with two main aims: first to develop a cheap, accurate and reliable method for measuring stresses in a mine pillar; second, to demonstrate that the stress cells give a reliable and accurate indication of these stresses. This program is now in the second year of funding by the Department of Energy, Mines and Resources and is being conducted in the Cominco mine at Vanscoy.

Eight different designs of a stress cell have been constructed after an intensive program of development. Twenty one cells have been prepared for installation in a selected pillar in the Cominco mine and, at the present time, 10 have been installed and are fully operational. Extra cells have been made for

circulation to the potash industry and are attracting interest due to the fact that they are cheaper and superior to commercially available cells.

Determining Ways to Minimize Surface Water Pollution by Agriculture

During the last decade, the livestock production on feedlots has become quite important in the economy of Saskatchewan. However, there is concern about the effects of such operations on the quality of surface waters. Therefore, a study was initiated to provide data on the quantity of nutrients which end up in surface waters from areas of concentrated livestock populations taking into account the distance of the feedlot to the nearest surface water, land use, topography, quality of manure and spreading practices. The study commenced early in 1975 and is 50% financed by the Family Farm Improvement Branch of the Department of Agriculture.

During the spring of 1976, in the second phase of the program, 658 water quality samples were obtained from 44 sampling sites in the Pheasant Creek basin. Of these, 158 samples were analyzed for phosphorus, total Kjeldahl nitrogen, nitrate nitrogen, carbon, potassium and suspended solids. Results of the study have shown significant correlations among various water quality parameters. Analysis of water quality data, supplemented by a qualitative technique using estimator indices, has provided useful results about the significance of livestock population, isolation distance, land use and topography on the quantity of nutrients transported. The analysis provided data on how the quality of manure and manure spreading practices can be managed properly to reduce pollution. An analysis of the hydrologic regime, and return periods of stream flows, has shown how the nutrient loading is related to the hydrology of contributing areas. Counts of total coliforms and fecal coliforms were made on selected samples from feedlots and manure spreading areas.

Results of the entire study, at the completion of the third phase, will be used to establish guidelines to evaluate the economic implications of proper waste management, determine the most desirable location of feedlots and recommend optimum spreading and land use practices to reduce pollution.

Recovery of Magnesium Sulphate from Alkali Lakes

Big Quill Lake, located in east-central Saskatchewan, contains large quantities of dissolved salts estimated to be equivalent to 8 million tons of sodium sulphate and 10 million tons of magnesium sulphate. The latter represents an important source of magnesium in this Province. However, the dilute nature of the lake brine makes conventional recovery impractical. The separation of the salts from the water and from each other would normally entail a large expenditure of energy in processing. A technique of freeze concentration which overcomes this large energy requirement is based on the method of spray-freeze desalination developed at the Council. It accomplishes a preliminary separation and recovery of magnesium sulphate by making use of the practically unlimited freezing capability of the Saskatchewan winter environment.

Magnesium sulphate can be used as a pulping chemical in the "Magnefite" process for pulping wood. This modification permits easier pollution control than the methods which mills in North America currently employ. Magnesium sulphate can also be converted by calcination to magnesium oxide for refractory manufacture or for conventional magnesium base pulping as practised in Canadian sulphite pulp mills. With funding from Saskatchewan Minerals and a Federal Department of Energy, Mines and Resources CANMET research agreement, an outdoor experiment was begun this past year at Big Quill Lake to demonstrate the feasibility of the spray-freeze concentration method. The objective of the experiment is to establish the reliability of the spray-freezing technique in recovering magnesium sulphate for further upgrading and marketing, and to quantify the degree of concentration and yields obtainable during the course of three successive winter seasons. Upon completion of the experiment, detailed process analyses will be made using the experimental data. The results of the first winter's operations indicated that the desired concentration effect was realized but experimental difficulties showed the need for futher experimental work.

Technical Assistance to Sodium Sulphate Industry

The Division maintains considerable competence in the technology of the sodium sulphate industry. Staff and facilities are available at any time to assist the five companies operating in Saskatchewan.

During 1976, studies were made on recovery schemes for undeveloped ore deposits, feasibility of new plants, plant design and in-plant problems.

A battery powered, digital recorder has been made to measure the water levels of saline lakes during the winter with an accuracy of $\pm$ 2 mm. This recorder converts pressure values directly into millimeters of salt water and corrects for the difference between distilled water and saline water. The recorder is being used to measure seepage from a small lake to study whether the lake can be used as a salt recovery reservoir.

Ceramic Research for the Utilization of Saskatchewan Clays

Saskatchewan possesses large reserves of clays suitable for ceramic use. The Council, therefore

has an ongoing program of study seeking uses for these clays, or more generally, Saskatchewan's non-metallic minerals.

The ultimate object is to assist with the establishment of new industries which would provide employment. So far progress has been slow. However, the Division has been more successful in keeping existing industries viable through the application of scientific knowledge and expertise.

Many of the studies carried out this year were at the suggestion of the Saskatchewan Department of Industry and Commerce. These include 1) further work on the possibility of making ladle brick from Eastend area stoneware clays; 2) investigation of the possible uses of magnesite from Mosher Lake near Flin Flon; 3) preliminary examination of the possible manufacture of whitewares, especially electrical insulators, from kaolinized sand from the Whitemud formation; 4) study of the suitability of commercially available Saskatchewan clays as artware clays.

Other matters to which some attention was given this year were:

- extraction of alumina from Boundary Dam flyash (problem described in 1963 annual report);
- further studies on the making of Amerindian pottery;
- the suitability of burnt shale from south of Shaunavon as light aggregate;
- making wall tile bodies from Rockglen clays and other local materials;
- examination of a sample of weathered basement (that is, a weathered Precambrian surface below the Paleozoic) from Neal Lake near Besnard Lake, west of La Ronge.

A considerable amount of sponsored research was carried out on behalf of Saskatchewan Minerals and Estevan Brick.

Early in the ladle brick studies, references were found in which the laboratory preparation and testing of ladle brick was described. These are bricks for lining containers for molten iron in steel mills. The brick need not be exceptionally refractory (ASTM says minimum PCE of 15, most actual bricks somewhere in the PCE 16-24 range). However, the brick must expand some 10-16% on reheating to working temperatures (2350°F). Quite a few Eastend area stoneware clays met the reheat expansion and refractoriness specifications, but most of these clays were from raw prospects or from pits of doubtful reserves. Fine grinding was found to be necessary to prevent iron concretions in the raw clay from forming slag spots. Further work was done on a sample from a pit on SE¼ 6-7-21-W3rd which had adequate reserves but its refractoriness was towards the low end of the acceptable range. Attempts were made to increase the refractoriness of the sample by admixing it with more refractory clay from Flintoft, but as the proportion of Flintoft clay increased, the reheat expansion value decreased more rapidly than the refractoriness increased. Consideration is being given to checking the reserve possibilities of those more refractory Eastend area samples mentioned above.

In the study on whitewares from kaolinized sand, chemical analyses were run on the body of a porcelain insulator and upon representative Eastend area kaolinized sands. The latter were found to be higher in iron oxides and in silica, otherwise the analyses were similar. Experiments were run in which the coarser material, hopefully iron oxide concretions and quartz, was screened off and the fines both analyzed and made into test pieces for firing. Test pieces were more open-firing than desired and not so white as desired. Too much of the fluxing constituents and mica were being screened off with the quartz, and too much of the iron compounds were coming through in the fines.

One commercially available clay submitted (A.P. Green's Claybank fireclay) seems suitable for artware; another from Pearson's pit (NE¼27-6-23-W3rd) is unsuitable, the drying and firing shrinkages being too great.

Technical and Economic Information for Transporting Solid Materials Through Pipelines

Large quantities of solid materials such as ores, coal, and other raw materials are transported long distances in Canada, to industrial areas for processing or to ports for export. Most of these solid materials could be transported by pipelines in the same manner as oil or gas. In fact, this is being done on an increasing scale elsewhere in the world. Six coal pipelines are being designed in the United States to transport 10 to 25 million tons per year each over distances as great as 1,000 miles.

A centre of excellence for the hydraulic transport of solids has been established at Saskatoon as a result of previous development work carried out by the Engineering Division. The centre is operated by the Division under contract with the federal government and undertakes studies for private industry. During the past year, a study on the transport of coal in crude oil pipelines was completed for the federal government and a new contract has been obtained to develop engineering data for the design of coarse coal pipelines. Contracts with private companies included studies on pipelining of coarse metallurgical coal, salt, mine tailings and brines.

Whenever time was available, staff investigated the problems of pipeline corrosion and erosion, particle attrition and raw materials of interest to Saskatchewan.

Resources Available in the Big Quill Lake Area

In 1966, the Division began a study on the climate, water and salt balances of Big Quill Lake. This lake has the capacity to sustain a 100,000 ton a year sodium sulphate plant for 30 years if an economical method can be found to extract the minerals from the lake water. The objectives of the study were to determine the origin of the salt and water in the lake and then, to develop a recovery process. This year data collection was completed and preparation of the final report was started. The report will deal with the economic potential of the lake for the recovery of minerals, recreation, wildlife, waste disposal and water supply based upon the data bank of streamflow, precipitation, lake levels, evaporation, and groundwater information.

The Value of Sloughs and Potholes

Wetlands created by the presence of sloughs and potholes in the prairies have considerable value from the agricultural and recreational points of view. They serve as sources of freshwater and groundwater recharge, as well as habitats for the production of waterfowl. There has been an upsurge of fish farming activity in permanent sloughs in Saskatchewan in recent years. However, additional land is made available for agriculture every year by draining the wetlands. This procedure in the long run would reduce the wetland area and increase the chances of flooding during spring.

The present study attempts to provide scientific data for the selection and management of wetlands from diverse points of view and for reducing the chances of long term adverse hydrologic effects. Twelve years of hydrometeorological data collected from about 120 sloughs in five areas are being analyzed with additional factors reflecting the socio-economic and agricultural aspects so that recommendations on the economic benefits of wetland use in the settled part of the province can be made. During the study, a method to compute evaporation was developed which has been applied to sloughs, lakes and reservoirs in Canada.

During 1975-76, statistical analysis of data was begun to produce waterloss and evaporation distributions and the methods to quantify the recreational and agricultural use of sloughs were reviewed. A short critique on computing evaporation from small, shallow bodies of water using the SRC's method and Meyer's formula was produced in an attempt to recommend a suitable method for the prairies.

A systems approach involving the various aspects of sloughs such as water storage, agricultural production, waterfowl production, and fish farming will be developed for evaluating the optimum use of wetlands in different regions of the province. It is anticipated that such a comprehensive approach will help to resolve the conflict of interests in the use of sloughs and potholes.

Predicting the Amount of Water Available from Spring Runoff in Small Drainage Basins

Small watersheds provide water, through snowmelt runoff, to dugouts and rural water storage projects. Designing of culverts and bridges requires reliable data to estimate peak and total flows. Very little is known of the hydrology of small agricultural watersheds less than 10 square miles in area in Saskatchewan, nor has the influence of land use on water yield been fully investigated. Runoff curves and return periods of flood peaks computed for a given area have to be corrected for man-made changes on the land. Changes in the peak and total yields invariably affect the water quality of streams.

This study, when completed, will provide hydrologic data from small watersheds, methods to predict peak and total flows from ungauged watersheds and a model to determine the influence of depression storage, land use and topography on the behaviour of small watersheds. The results of the study will be used to assess the effect that the drainage of wetlands will have on the occurrences of floods in farm lands. The study will provide important information for the management and allocation of surface water projects.

Producing Potable Water from Brackish and Saline Water Using Natural Refrigeration

In much of the settled area of Saskatchewan, the only well-distributed and reliable water source is brackish groundwater. Small communities and individual farmers cannot afford to bring in potable water by pipeline and need a method of reducing the salt content of the brackish water to provide good quality water. Commercial desalination processes are available but they are expensive to operate at the small capacities required in rural Saskatchewan. The Division has been investigating various methods of desalinating water by natural freezing through utilizing the natural refrigeration available during a prairie winter.

Spray freezing is being investigated at the present time. With this method, brackish water is sprayed continuously during the winter to produce an unconfined mound of ice. If the water is sprayed fast enough, the mound can be maintained near the freezing temperature, in which case the salts will concentrate in brine surrounding ice crystals which are almost pure. The brine is denser than the ice, consequently, much of the brine will drain to the bottom of the ice mound during the winter. In the spring more of the brine will be flushed from the ice by the initial ice melt. The brine can be discarded and the remaining ice melted and stored for use as potable water.

During the 1975-76 winter, spray freezing trials were conducted on a synthetic brackish water at a site near Saskatoon and on natural brackish waters at Armley, Blucher, Bruno and Frontier. Near Saskatoon one unit with a single spray head was used; at Armley, Blucher and Bruno two units each with a single spray head were used; and at Frontier two single spray head units and a multiple unit with five spray heads were used. These trials include tests on major types of brackish groundwater found in Saskatchewan and cover a range of climatic conditions. As in previous years, yields were good with more than half the input water being recovered with less than half the salt content of the input water in most trials. No difference was observed in performance between the single and multiple spray head units at Frontier.

All of the product from the three units at Frontier again was stored in a shallow aquifer by using an infiltration pond. Infiltration rates remained satisfactory.

This project is being funded under the joint federal provincial ARDA program.

Engineering Workshop

The Engineering Divison maintains a diversified workshop which undertakes design, construction and initial testing of laboratory, oilot plant ano full scale equipment for all divisions of the Council. In addition, the workshop operates the Council buildings, storage facilities and some field installations. A full preventative maintenance program is in effect for most Council equipment.

The following function has been initiated on a small scale and it gives indication of further expansion. Several government departments have an intermittent demand for the solution of technical problems and cannot justify the full-time employment of a technical branch. The Council, as a research and development arm for the Provincial Government, is ideally placed to provide technical support to such departments and has the wide range of expertise that is necessary for this function. There are indications that this service will become a major feature of the Council's activities in future years.

A useful example is provided by the services of the Engineering Division to Environment Saskatchewan over the last year. A water sampler, to a customized design, was developed and constructed at the Council, and is now being applied successfully to water sampling by that department. Recently, it contracted the Council to repair and relocate a Robot Monitor Water Sampler, and to maintain it in good working order over a period of five months. This service required specialized electronic skills and a thorough knowledge of the physical and chemical processes built into the analytical cells of the sampler.

The sampler is an intricate piece of equipment that requires specialized maintenance on a regular basis. Over the years, this equipment had fallen into a state of disrepair and required two man-months of effort to restore the sampler to a fully operational condition. This expensive equipment now has been reclaimed and is operating better than ever before at a new site in the Qu'Appelle Valley.

SPRAY FREEZING to produce potable water from brackish and saline water using natural refrigeration.

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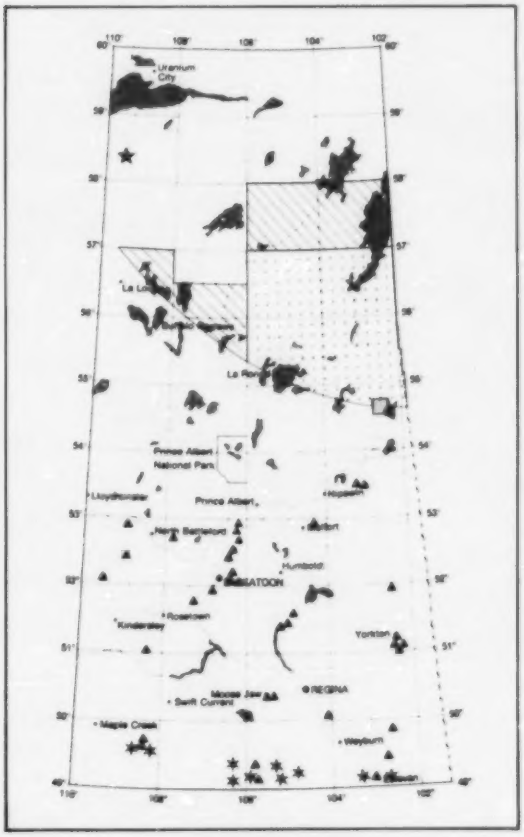
RESEARCH COUNCIL

ENGINEERING

REPORT OF THE GEOLOGY DIVISION

R. G. Arnold, Head



EXPLANATION

- Glacial Geology
- Geochemical Studies
- Volcanism and Ore Deposits
- ▲ Observation Well
- ★ Uranium Research
- ✶ Lignite Coal Evaluation

Exploration for Ore Deposits in the North Using Geochemical Methods

The geochemistry program has been involved with studying the distribution of ore metals and associated trace elements in various media, in the geological environment. The objectives of this work have been to modify existing methods of geochemical prospecting for use in Saskatchewan conditions.

The final result of this process has been the development of a versatile scheme of multi-media, geochemical sampling in which all pertinent media such as bedrock, soils, muskeg, lake and stream sediments are sampled and analysed. Computer format field cards were designed to standardize the reporting of field observations such as sample descriptions, terrain and vegetation features, etc., required in the subsequent interpretation of the geochemical data. A computer program was assembled to edit, compile and to provide distribution statistics for the various media sampled. Computer plotting of the resulting information was found to be mandatory for efficient error-free presentation.

No new geochemical field programs were undertaken in 1976. It was generally a year of consolidation in which the reports of past work were prepared for publication. Two reports, yet to be published, summarize geochemical surveys over mineralized boulder trains at the Duddridge Lake uranium deposit and at the George Lake lead-zinc deposit.

Lake Sediments as a Prospecting Medium in Northern Saskatchewan

The single geochemical field program this year involved an investigation of lakes whose sediments are anomalously high in uranium, copper, zinc or arsenic as indicated by a Geological Survey of Canada helicopter lake sediment survey in 1974.

The 1974 survey involved the collection of 3844 center, lake bottom sediments, at a density of one sample per 13 square kilometres, in the southeast part of the Precambrian. The objectives of the Council's work were to locate the source of anomalous metals in the sediments and to assess the economic potential of the source. To accomplish these objectives, each anomalous lake was resampled in detail and, in addition, samples of bedrock and soils were taken from the margins of lakes. To date, 51 uranium, 25 copper, 4 zinc and 10 arsenic anomalies have been investigated. Several small copper and zinc sulfide zones were found in

meta-amphibolites, whereas uranium is derived from pegmatites in granitic terrain.

All sample media collected on geochemical field projects are analysed by the Geology Division's geochemical laboratory. The normal suite of elements determined are copper, zinc, nickel, lead, molybdenum, cobalt, uranium, iron, manganese, organic carbon and arsenic where appropriate.

This is the second year of a program carried out under contract with the Saskatchewan Department of Mineral Resources (DMR) as part of a Federal-Provincial (DREE) geoscience program.

Geology and Geochemistry of Saskatchewan Uranium Occurrences

The discovery of three significant uranium areas in Saskatchewan at Rabbit Lake, Cluff Lake and Key Lake, within the last eight years, demonstrates that the geological conditions in the Precambrian of Saskatchewan are very favourable for the discovery of additional uranium ores.

A program to study the genesis of the new uranium discoveries was initiated in December 1975 and the initial work is being done at the Rabbit Lake deposit near Wollaston Lake. Initial studies include geological mapping of the open pit and adjoining areas, mineralogy and geochemistry of ores and wallrocks, alteration, stable isotope and liquid inclusion geothermometry. The results of studies to date indicate a complex history of primary ore remobilization combined with several episodes of faulting and alteration.

The ultimate aim of such studies is to gain an understanding of the environment of uranium deposition so that geological and geochemical criteria can be developed for recognizing favourable areas for uranium exploration. This is a joint project with DMR.

Mapping of Glacial Deposits in the North as an Aid to Mineral Development

Glacial drift is a paradoxical material because it is both an advantage and a disadvantage in mineral exploration. It is frequently a disadvantage because it obscures the bedrock in which metallic mineral deposits occur. More than one-half of the Precambrian bedrock in Saskatchewan is mantled by these sediments. Glacial sediments occasionally can be used to advantage as they can contain ore minerals derived from underlying ore deposits exposed on the bedrock surface. Geochemical sampling and prospecting of tills frequently can detect the dispersed ore minerals which can then lead the geologist to the source in the bedrock surface.

Field studies of glacial sediments, carried out during the year, include reconnaissance aircraft mapping and sampling at an average density of one site per 100 square kilometres. To date approximately 100,000 square kilometres have been mapped in an area between the southern boundary of the Precambrian and 58° north latitude. Specific areas in which mapping was done include (National Topographic System) 74H, 64E, 74B, 73O and 73C, where 610 sites were investigated. In addition, 16 auger holes were emplaced along roads by truck mounted equipment and a seismic survey was conducted to measure drift thickness. Preliminary 1:250,000 Quaternary Geology Maps of each mapped area have been prepared.

This is the third year of a four year program carried out under contract with DMR as part of a Federal-Provincial DREE geoscience program.

The Mining Potential of the Amisk Lake Area

The Precambrian volcanic rock sequences, that begin in the Amisk area and stretch eastward to Flin Flon and on into Manitoba, are second in Canada only to the Abitibi volcanic region of Ontario and Quebec in terms of total production of copper, zinc and lead. Despite its economic significance, the volcanic stratigraphy and geochemistry of portions of the Amisk-Flin Flon volcanic region are relatively poorly understood. The current project in the Amisk Lake area of the Flin Flon region is designed to demonstrate the value of initial, thorough geological and geochemical studies as an exploration target-selection technique. These relatively inexpensive, geological and geochemical studies can then be followed by geophysical methods concentrated in the more promising areas.

This is the final year, of a three-year mapping program. Over 260 square kilometres of ancient volcanic terrain have been remapped and a number of economically promising areas have been identified for future exploration. The core of these areas contain high silica content rocks believed to be related to old volcanic centres which are frequently known to be associated with ore deposits. Field techniques used on the project have included reconnaissance and detailed trace metal geochemical work and lithological, structural and pyroclastic mapping.

Saskatchewan Lignite Resources Evaluation Program

In 1971 a lignite resources evaluation program was initiated in the coal fields of southern Saskatchewan. The principal objectives of the program are to determine the geologic framework for the Ravenscrag Formation which is the principal coal bearing formation, to outline areas of important coal occurrences, and to determine the quality and quantity of coal on a seam by seam basis. The evaluation program is a co-operative effort with DMR and the Federal Department of Energy, Mines and Resources (Energy Research Lab and the Geological Survey of Canada).

An evaluation of present data provides a

preliminary estimate of lignite resources as 5.7 billion tons. Lignite resources are defined as all seams at least five feet thick and within 150 feet of the present land surface, and seams three to five feet thick that have an overburden-to-coal-seam-thickness ration of less than 15:1.

The evaluation program will be completed this year with the publication of an atlas of maps showing coal thickness, overburden thickness, coal structure and coal seam variation in fence diagrams and cross-sections for each significant coal seam in each of the major geographic regions containing economic coal resources (the Estevan, Willow Bunch, Wood Mountain and Cypress areas). An accompanying report will discuss the regional geological setting of the coal resources, provide an evaluation of current mineable resources on a seam by seam basis, and explain the program design and the data handling systems that were designed for this program.

Lignite Reserves Evaluation and Regional Groundwater Monitoring at Coronach for SPC

The evaluation of lignite reserves on Saskatchewan Power Corporation leases has been a continuing program since 1971. The program has consisted of drilling, sampling, the preparation of maps of seam thickness and structures, and of the character and thickness of overburden.

During 1976-77 a limited amount of detailed drilling was conducted at Coronach to provide the control necessary for designing the original mine plan to supply the Poplar River Power Plant. In addition, coal cores were obtained at selected sites within the main mine area.

Dewatering of the mine area, the water storage reservoir and groundwater production at the power plant are expected to alter the groundwater regime in the Coronach area. To assess preproduction groundwater levels and to monitor the fluctuations in these levels during lignite production, 57 piezometers have been installed in the region. These regional monitors will provide a management tool and the means of assessing the effects of the coal mining operation on the regional groundwater regime.

Groundwater Geology and Aquifer Evaluation

This program's purpose is to compile and interpret information on the groundwater resources of the plains area of Saskatchewan as an aid to the development and management of groundwater resources. Groundwater is an important and widely used resource in the plains area of the Province. Generally, farms, villages or towns not on the major river systems have to develop and maintain their own water supply because of the dispersed nature of the population.

Locating groundwater, in the past, has been largely an inefficient trial and error process because of a lack of basic geohydrologic data to guide the exploration program. The continual accumulation of information on the geology, location and characteristics of aquifers and water quality has resulted in an improvement in the efficiency and success of groundwater exploration.

A FLOWING WELL near Dundurn provided practical knowledge of the geohydrology in the area, as well as, the capping procedures.

Several continuing programs contribute directly to the groundwater data base. Groundwater levels have been continually monitored by a regional network of 40 observation wells equipped with automatic water level recorders. Computer systems for storage and retrieval of the water level information, and groundwater quality information are operating. A groundwater information service, provides information on the availability and quality of groundwater to government departments, communities, well drillers and private individuals.

Contract studies engaged in during the year included:

- a continuation of groundwater evaluation at Yorkton and Regina for Environment Saskatchewan.
- an examination of brine and pond dikes at potash mines for the DMR and
- the evaluation of the geology and groundwater regimes in connection with studies of salt migration in soils.

Environmental Geology

The purpose of this study is to compile available information on the nature and origin of glacial deposits in the settled area of Saskatchewan. Such information is the framework for geotechnical investigations such as the study of landslides, exploration for groundwater and sand and gravel resources, and land use studies.

During the year, a compilation of data on glacial

geology was completed for the region beginning at the southern boundary of the Province north to 58° north latitude, i.e. just north of Cree Lake. On the basis of this work, an understanding has evolved of the history of deglaciation and of the glacial processes involved.

Additional studies, undertaken during the year, included the preparation of a paper on the Wascana Creek volcanic ash deposit and investigations of glacial thrusting processes at several sites in the plains area of the Province.

Fort Qu'Appelle Geolog

This study was intended to compile a booklet on the environment of the Fort Qu'Appelle area for the public.

The Fort Qu'Appelle environment was portrayed in a 65-mile road tour with 11 stops at which the environment was explained by means of photographs, maps, and cross sections. This project was carried out under contract with the Museum's Branch, Saskatchewan Department of Tourism and Renewable Resources.

Cartographic Unit

Responsibilities of this five-man unit include:

- design, preparation and production of all division publications, maps and displays;
- library of topographic and base maps, air photos, mosaics, E-logs and field support data; and
- co-ordination of provincial airborne remote sensing tasks by the Canada Centre for Remote Sensing, Ottawa.

Completion of 1:50,000 scale mosaics, from the most recent coverage per NTS area, has been completed from 49° to 58° latitude. A 1:1 million base map of the Province is still in development and will proceed to completion as priorities permit.

Major projects undertaken in 1976 include the Meadow Lake Geolog — a tourist guide to geologic features in the north-central Provincial Park, three geochemical reports, a preliminary Pleistocene map of the Wollaston-Pelican Narrows area, a report and atlas of the Federal-Provincial Coal Study, a geolog of the Ft. Qu'Appelle area and a groundwater resources map of the Cypress area.

The Cartographic unit frequently is called on to consult and advise on cartographic problems in various government departments, agencies and the private sector. Currently the unit is assisting the Saskatchewan Department of Highways and Transportation in development of a new Provincial Road map which will be readily adapted to metrification.

However, current heavy demands on this unit's services, within the Division, make it necessary to provide consultation services on a restricted basis.

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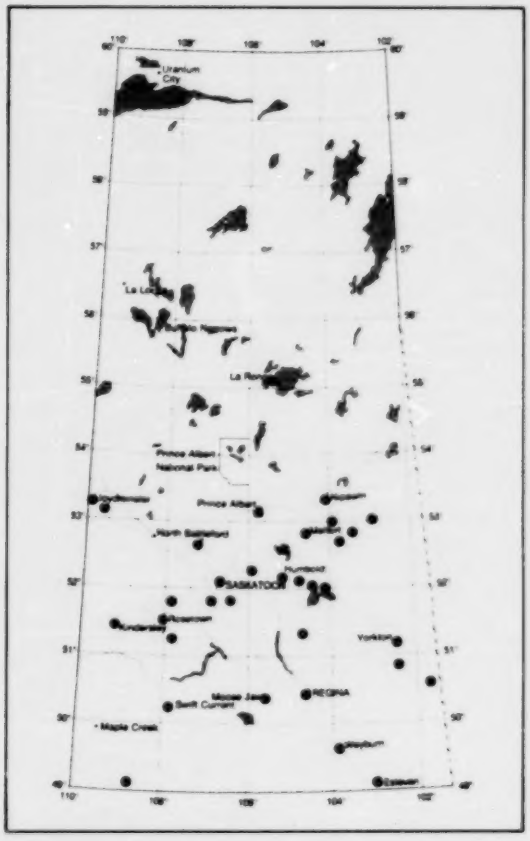
REPORT OF THE INDUSTRIAL SERVICES DIVISION

I. S. Evans, Head



Information officers provided assistance to industry in these areas in 1976.

TECHNICAL INFORMATION SERVICE

The role of the Technical Information Service (TIS) is to identify problems in Saskatchewan manufacturing, processing and extraction industries.

Where appropriate, the Service, on a free and confidential basis:

1. provides information
2. guides, counsels, recommends or assists industry to take the needed action
3. increases the level of scientific and technical knowledge in industry.

During the past year, TIS engineers made 360 calls on Saskatchewan's manufacturing industry. Direct contact is necessary to remain current on client needs and to provide assistance in implementing new technology. Necessary information is obtained from personal knowledge, the SRC library, the Canadian Institute of Scientific and Technical Information, equipment suppliers, and appropriate specialists.

The following case studies illustrate the value of the program.

A Saskatoon firm bid on a large contract and was requested to provide sound level readings for their product. TIS located the required instrumentation and predicted likely sound emissions for the new models. This service enabled the company to obtain the contract. After the product was manufactured, measurements confirmed that sound level specifications had been met.

TIS visited a small new machine shop, near Saskatoon, employing four people. The firm was considering starting a regrinding service for machine tool cutters. Through contact with machine tool manufacturers and use of the Saskatchewan Information Retrieval Centre, it was possible to provide the firm with information on the use and price of a suitable sharpening machine. TIS was able also to give the names and addresses of suppliers and a good estimate of how much to charge for the service. This service could provide an additional profit of up to $1500 per year.

TIS publishes *The Catalyst*. Titles during the year included:

Energy Conservation — Are We Using Our Brains
Information Today —
Doing It Right the First Time
Striving for Efficiency
So — You Think You Can Weld?
Fuels and Their Conservation
Prescription for Recovery —
Research and Society

INDUSTRIAL ENGINEERING PROGRAM

The industrial engineering program is part of the

NRC-TIS program mentioned previously. The continued financial and technical support of the National Research Council is gratefully acknowledged.

The program is designed to assist industry to improve its effectiveness in any facet of its operations. The industrial engineer stresses an approach which provides more efficient use of the company's resources of men, money, machine and management.

Specifically, the industrial engineer will help industry improve productivity through better plant layout, improved manufacturing processes, enhanced design, advanced use of materials, production planning and scheduling techniques, and reduction of waste. This approach can help in improving financial and marketing techniques.

The industrial engineering program publishes *Industrial Business Management*. This pamphlet is mailed regularly to about 3,000 individuals throughout the world.

Some of the titles during the past year were:

- Industrial Product Design
- Production: The Neglected Business Function
- Managing Your Environment
- A New Approach to Productivity Improvement
- Behavior Modification: A Human Resource Management Technology
- Simple Accounting Technique for Successful Operation
- Productivity and Profits.

The program has provided increased production, industrial growth and more jobs in the Province.

Some examples of the program's assistance are:

- A feed mill manager wanted to improve the productivity of his plant. An industrial engineer recommended a wage incentive program based on productivity, resulting in a better than 20% gain in productivity, allowing the company to be more competitive. The incentive plan was later applied to the company's salesman, who responded with a 30% increase in sales.
- Another company wanted to house under one roof, five different manufacturing operations. With the help of an industrial engineer, a rational plan was developed to accomplish this merger, including a detailed layout of the expanded operation. Such rationalization of the company's resources will permit an increase in production and sales for minimum capital costs.
- An agricultural firm was losing large sums of money in its operations. As a result of a thorough study of the company, specific facets were identified for improvement, principally that the company operated below its production capacity. Based on the recommendations of the industrial engineer, the Board of directors of the company took the necessary steps and avoided bankruptcy, saving 20 jobs and increasing sales by 70%.
- Finally, a new company was in need of financing to continue its growth. The industrial engineer provided assistance to convert the physical plan into financial projections. This assistance allowed the company to plan the necessary financing for increased plant capacity and working capital. The continued use of proper budgeting technique should allow the company to plan its growth in an orderly fashion.

NRC-TIS ANNUAL CONFERENCE SEPT. 13-17, 1976

Each year, the NRC-TIS Directors meet in conference with the field officers, who provide the Technical Information Service in the provinces.

The conference location is moved annually from province to province. This year it was Saskatchewan's privilege to be host at a conference held at Moose Mountain Provincial Park with about 40 delegates attending from all provinces and Ottawa. The Ottawa director and each province gave a report of their activities during the previous 12 months. Following discussion of the reports, the conference concentrated on the selected theme — *Designing the future of TIS.*, using the Delphi method of future planning. A conference report is being prepared.

SPECIAL TECHNICAL PROJECTS

The purpose of this activity is to make professional engineering research expertise available to Saskatchewan industries. Priority is given to manufacturers with product or production problems that require a significant degree of investigation or research.

During 1976, 11 projects were completed. The level of involvement ranged from one to 60 man days, with each project initiated and funded by a Saskatchewan company. In some cases, the company received financial assistance from a provincial or federal government program. The types of projects included production engineering, product design, and mechancial or structural failure investigation. The following two representative case histories are of a large project that was completed and a project that is currently in progress.

CASE STUDIES

Fairford Industries, Moose Jaw, Saskatchewan, asked SRC for design data to assist them in marketing Quonset buildings. Local building regulating agencies were reluctant to approve this type of structure for use as public buildings, especially in areas that experience severe snow loads. There was evidence of the need of a proven design theory which an engineer could use to

determine the suitability of a given building for a particular application.

A preliminary investigation indicated that this structure was unique and only one American competitor had made any attempt to develop proven engineering data. Thus, a research project was conducted to obtain a better understanding of the structural performance of Quonset buildings of the type manufactured by Fairford Industries.

The project consisted of:

- A literature search to determine the state of the art in designing these buildings.
- Testing of actual arch sections to determine their important structural properties.
- Analysis of test results in relation to building performance.

The project was funded jointly by Fairford Industries and the Saskatchewan Department of Industry and Commerce. Other agencies and individuals that assisted in the project were the Division of Building Research, Prairie Regional Lab of the National Research Council, members of the staff of the Universities of Saskatchewan, Windsor and Cornell.

The Industrial Services Division (ISD) is presently assisting a company in the design of a large trailer. If commercially successful, this assistance could provide many additional jobs and a sizeable expansion for the firm.

This design has been developed using structural models to verify the theoretical behavior of the trailer. Design criteria were chosen by analysis of failed trailers in the intended working environment. These analyses were facilitated by the on-line, interactive computing facility in the SRC.

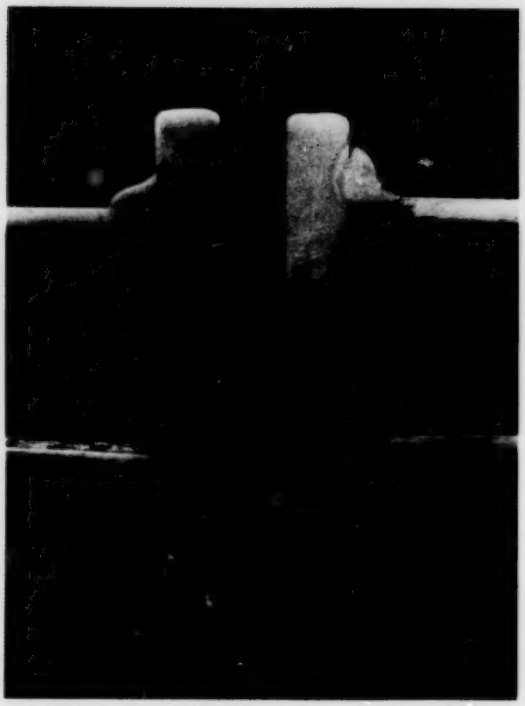
Following the installation of a new data route to Toronto, the ISD will use the finite element stress analysis program there to give a more detailed stress analysis of the proposed structure. Such computer programs have been used for many years with great success in high technology industry. ISD plans to offer this very powerful design tool to Saskatchewan's industry for future projects which may be generated here as part of the service. A stress analysis of some locally designed machines could result in a reduced failure rate or in a saving of material.

WELDING IMPROVEMENT PROGRAM

A project to improve welding and fabrication in the Province is supported by the Canadian Welding Development Institute and NRC.

Two *Welding Metallurgy* courses were attended by industry supervisory staff. Technical talks were given to:

- The Canadian Welding Society, Regina, Chapter,



WELDING IMPERFECTIONS can cause dangerous weaknesses in metal structures.

- The Prairie Agricultural Machinery Institute, and
- The Annual NRC-TIS Conference

Materials for two proposed welding courses at Canadian Penitentiaries were reviewed and criticisms written.

Approximately 70 metallurgical problems, half of which involved welding, were investigated. Investigations were made on behalf of local government agencies, the Federal Government, the Ontario Research Foundation, and Saskatchewan Industries.

CASE STUDY

A few links failed in a 600 foot bucket elevator chain used by a local potash industry.

The 1976 cost of replacement of the chain is approximately $42,000.

A metallurgical investigation of links that failed, links that had not failed and new links revealed no appreciable differences in composition, heat treatment or mechanical properties.

The failure was due to a fatigue crack which commenced at a change in section. The hole for the pin was not round but had two flat sides and where the flat side met the radius there was a stress concentration.

The company was advised not to replace the chain. Instead the following alternatives were recommended:

- Replace the side bars once a crack was visible;
- Replace the complete link;
- Weld the cracked side bars and reuse.

Since the links cost approximately $70.00 each, the company was advised initially to try the welding recommendation.

SASKATCHEWAN INFORMATION RETRIEVAL CENTRE

This project provides the specialized techniques of obtaining scientific and technical information including on line information retrieval, to SRC clients and industry in the Province. On line information retrieval provides access to over 10 million computer searchable citations in approximately 50 data-bases, which correspond, in most instances, to published abstract journals. The data-bases are made available by Canadian Institute of Scientific and Technical Information, QL Systems Ltd., Lockheed Information Systems, and Infomart. A local computer terminal hook-up provides access for direct searching.

Many traditional bibliographic and reference tools also are available to aid the identification of information relevant to a client's need, and library resources are available to locate and procure documents containing the required information. The facilities to locate and obtain information in the scientific and technical literature are resident in the SRC. This project attempts to match the capabilities with client and industry requirements.

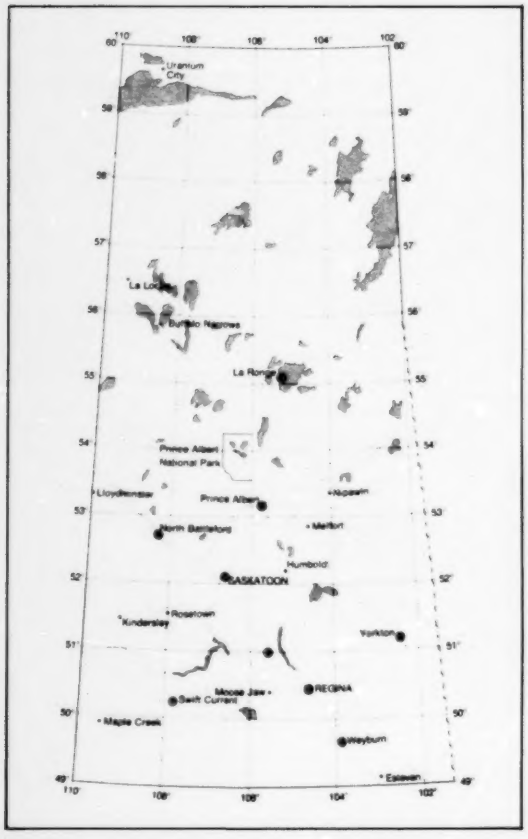
A search of one data-base to locate information on the effect of galvanizing on the fatigue strength of steel took six minutes search time and resulted in 21 references being selected.

An extensive search was conducted for a design contract undertaken by the SRC for Fairford Industries. The initial search provided necessary background information and led to a clearer definition of the problems. Consequently, a second search, over several data-bases, was conducted using the more precise definition of the area of concern. The results of the second search provided, more specifically, relevant information and gave evidence of the necessity of conducting updates by selecting some particularly pertinent references cited in the time elapsed since the first search. While the information provided was of significance in itself, the resulting direct contact with researchers who conducted similar studies, provided a most important input to the project. This contact was a side benefit to literature searching.

Effective information service must meet the needs of the user. At present, the service offers literature searching and document procurement, primarily in the field of scientific and technical literature. The Centre is exploring the range of beneficial applications for these services. Consequently, the Centre is providing a better definition of client requirements for information, with the prospect that a service tailored to the needs of the potential clientele, may be designed.

MANAGEMENT SERVICES

T. P. Pepper, Acting Head



While management services are available anywhere in Saskatchewan, the major areas of 1976 activity are shown here.

During 1976, SRC was encouraged to provide extended service both in Management and Resource Development, and in Environmental Studies with emphasis on the management of Environmental Impact Assessments.

While, as an interim measure, environmental work was continued within the existing divisional structure, management services were temporarily set up separately in anticipation of structural reorganization of SRC's operations.

A staff of three have undertaken a number of projects.

Many thousands of tons of flax fibre are produced along with the annual Saskatchewan flax seed crop. Most of this fibre is waste. If the fibre can be used in paper or linen, farmers might realize some $5,000,000 annually. SRC is coordinating the efforts, of various agencies of the Provincial and Federal Governments and of the private sector, in an attempt to develop commercial uses for this waste product.

An SRC consultant provided assistance in developing a plan for a new organization structure for the finance branch of a Provincial Government department.

A detailed study, on cost- and revenue-sharing, was carried out for the Saskatchewan Urban Municipalities Association.

Under the Productivity Enhancement Project (PEP) of the Federal Department of Industry, Trade and Commerce, an employee incentive earnings program was developed to improve a small company's productivity and profits.

During the year a series of short market, feasibility, and other studies were completed for the Department of Industry and Commerce. Also, management consulting personnel addressed various groups and associations.

Publications

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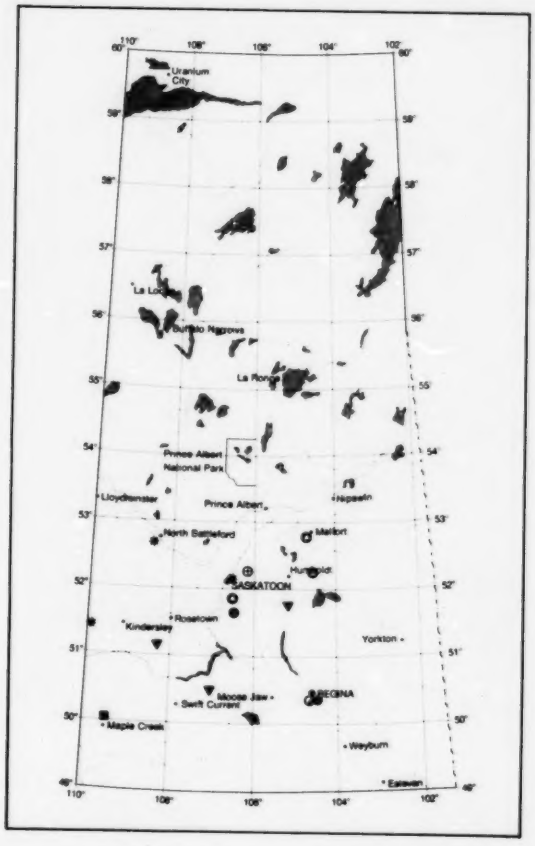
Scharf, Alan, D., *Wood-Chopper's Selling Secrets*. Marketing Times (Journal of Sales and Marketing Executive International) May/June 1975.

Scharf, Alan, D., *20 Ways to Make Better Use of Time*. Canadian Business, September 1975.

Adeland, Robert, B., *Developing Your Staff*. R.M.A. Bulletin, December 1976.

REPORT OF THE PHYSICS DIVISION

J. Maybank, Head



EXPLANATION

- Pesticide Drift
- Ice Nuclei Sampling
- Grain Dust Investigations
- Air Sample Investigations
- Water Well-Cleaning Aid
- Saskcomp Work
- Climate Survey

Climatology

A continued focus on climatic data for agriculture highlighted this past year's program. An experimental agroclimatic bulletin for the Saskatoon area was prepared on a weekly basis and disseminated through radio. Now a qualitative evaluation of this program is under way.

Preparation of a multi-color map at a scale of 1:1,500,000 has been completed showing mean monthly and annual precipitation and temperature, extreme maximum and minimum temperatures for the period of record, mean snowfall, frost-free season data, precipitation frequency and other climatic data. More than 50 stations in the arable portion of the province are shown in association with information concerning dominant soils. Printing date for this map is contingent on funding.

A major co-operative program was undertaken last year with Agriculture Canada, involving the interaction of Climatic Data with the development of grasshoppers. Near real time data collection, data analysis and synthesis were required to fill gaps in the data.

Preliminary work has been done on the preparation of heating degree-day tables for selected Saskatchewan centres. This information will facilitate design of heating systems for energy conservation.

Work continued on the archive of solar radiation data for Saskatoon. Total global radiation for Saskatoon on a daily basis now is available in a computer-sensible form for Saskatoon in the period 1953 to 1976. Hourly radiation information is also available for the 1970's. Improvements in the solar radiation equipment and a complete sensor calibration were accomplished during the past year.

A study of climatic factors affecting water balance of Canadian lakes since the last glaciation was begun under contract with the Canada Centre for Inland Waters. This program, primarily a critical review of literature, will be under intense study during the fourth quarter of the fiscal year.

Climatological Reference Station

With financial assistance from the Atmospheric

Environment Service of Environment Canada, SRC continued to operate a benchmark climatological station at Saskatoon. A system was implemented for providing the automatic collection of data in the lowest 8m of the atmosphere, for energy balance and air pollution studies. An extended annual summary was issued which compared conditions in 1975 to those experienced over the previous 30 or more years at Saskatoon. Regular, monthly weather summaries also were produced and distributed to clients in industry, government, agriculture and the mass media. Benchmark station facilities were used in co-operative programs with the University of Saskatchewan, Agriculture Canada and others which covered topics such as: *Outbreak of Parasitic Diseases in Horses, Overwintering Temperatures Experienced by Gophers, Calibration of Solar Radiation Instruments, and Forecasting of Grasshopper Hatch.*

Near the end of the year, a University of Saskatchewan seismograph unit was installed at site. This co-operative program began on a temporary basis, but will become permanent should the station site prove satisfactory for seismic observations.

Remote Sensing

Tests of remote sensing techniques, amenable to use with small captive balloons, were carried out in the Saskatoon area. A 35 mm camera system was employed with various film and filter combinations on targets such as agricultural plots, sewage outfalls, traffic patterns and a variety of other targets. A report on these activities is in progress. The co-operation of Mr. W. B. McCoy was gratefully acknowledged in respect to this program. Non-photographic sensors, including an infrared thermometer and a spectral radiometer, were tested in respect to study of an effluent plume in the North Saskatchewan River. This work was carried out jointly with the College of Engineering, University of Saskatchewan. A report on these activities is in progress.

Applications of density slicing techniques to Saskatchewan aerial photography interpretation problems have been carried out with the kind assistance of the Alberta Remote Sensing Centre. An investigation of the possible use of ultraviolet photography in the detection of arson was carried out in conjunction with the Saskatoon Fire Department.

Pesticide Spray Drift Studies

This program, financed partly by a Canada Agriculture research contract, and carried out co-operatively with Canada Agriculture staff at the Regina station, is designed to investigate ways to improve farm spray application of pesticides while at the same time minimizing off-target drift and the hazards it produces.

One significant finding in past years has been that while most of the newer developments, namely, coarser spray nozzle tips and chemical thickeners, do effect a significant reduction in drift, these developments also result in unacceptably large variations in swath deposits. In practice therefore, farmers would have to apply greatly increased amounts of herbicides to achieve the desired level of weed control, thus at least partially negating the lessened drift hazard. This problem received considerable attention this year, starting with a detailed field trial investigation of our basic method of measuring swath deposit uniformity. Several different arrays of petri dishes were used as ground samplers, including a random array. It was found that the basic 24 dish grid gave an acceptably realistic measurement of the total deposit and its variability. Exposure of small plastic replicas of weeds provided an estimate of foliage dosage as a function of sampler amounts.

With this baseline information, the twin boom sprayer was used to provide for a direct trial by trial comparison of a standard operation from one boom with a modified operation on the other boom. A series of trials was carried out varying nozzle orientation to the ground, and varying the amounts of thickener used over the range recommended by the manufacturer. In general, it was found that each step, designed to improve deposit pattern, caused a concommittant worsening of drift control, and vice versa. As an example, a particular nozzle when pointed directly at the ground during spraying produced a fairly ragged, uneven swath deposit but gave excellent drift control. However, when tilted or mounted in a horizontal position, swath uniformity improved but off-swath drift increased. This incompatibility of two desirable characteristics for many sprayer systems indicated that most steps taken so far in practical drift control at the nozzle design level, or through modifications to solution properties, may well be inappropriate. Clearly, different technological approaches are required.

One other major factor in pesticide spray application concerns the hours of early morning, when atmospheric conditions tend to be stable. A frequent assumption has been that this period was ideal for such operations because drift would be small. This assumption appears to be true only if the weather is calm, or at the least if the windspeed is very low. If the wind is light to moderate at this time of day, a condition that can occur simultaneously with slightly stable conditions (defined meteorologically as a small temperature inversion), drift will occur and can in fact be more hazardous to nearby, susceptible crops and shelter belts than would be the case with the same or higher windspeed later in the day. This hazard develops because the temperature inversion would tend to keep the drifting droplets concentrated close to the ground. In contrast, under sunny, mid-afternoon conditions, air turbulence would tend to diffuse the droplets upward and so dilute the drifting cloud which decreases the number of droplets that would

impact out on low foliage. To test these considerations, a series of early morning and evening trials was carried out this year.

Finally, a series of trials was carried out under a separate research contract for a chemical spray firm. These trials involved comparisons of new formulations with the more standard ones, when each was applied by typical aircraft spray operation.

Atmospheric Grain Dust Studies

In the early part of the year, a detailed investigation of airborne dust concentrations and fallout rates was undertaken, under contract to the Atmospheric Environment Service, Environment Canada. The purpose of this phase of the research was to relate day by day grain dust levels to the local wind, temperature and general weather conditions and to the grain-handling work actually underway in the local elevators nearby.

GRAIN DUST — magnified 2500 times by an electron microscope.

Further chemical composition, particle size and particle shape analyses were carried out on the samples that were collected. Elementary diffusion model theory was applied to the results to provide an explanation of the downwind dispersion, dilution and deposition patterns that would be expected. A written report about this work was given at two grain dust and health seminars during the year. One took place in Saskatoon and the other, under Canada Department of Labour auspices, in Ottawa.

As a result of the second seminar, it is planned to design and carry out a major cooperative program on grain dust levels and possible disease hazards. The non-medical part of the study would be undertaken by Council staff. To prepare for this study a more extensive survey of grain dust concentrations in a number of rural Saskatchewan elevator points has been commenced.

Electronics Laboratory

In addition to providing specialized support for the Council's research program, the electronics laboratory continued to provide extensive contractual service to a number of outside agencies in government, university and industry. This service included consultation, design, fabrication and maintenance of electronic instruments and systems.

In 1976 the electronics laboratory provided service to the following agencies: Saskatchewan Power Corporation (both the research and development group and the technical services group), Saskatchewan Department of Highways and Transportation, Spartan Controls, Intercontinental Packers, Saskatchewan Institute of Pedology, Department of Geological Sciences (University of Saskatchewan) and Mercury Printers Ltd., Saskatoon.

A microcomputer development system was purchased by the laboratory, with which system instruments such as controllers, data acquisition systems, etc., may be developed using microcomputer techniques. This system is not only a cost effective approach to instrument design, substituting software for hardware but in addition, increases design flexibility and simplifies data transfers to larger computers.

The Electronics Laboratory is endeavouring to be as useful as possible to government and industry in the province. With this aim in mind, a brochure describing the facilities of the laboratory is being prepared.

Precision Instruments Facility

During the past year, the major effort in instrument design and construction occurred in response to requirements from outside the Council itself. Internally, instrument repair and servicing maintenance was the primary function. This service included some major modifications to field sampling equipment for the Physics and Geology Divisions. In addition, a specialized sieve shaker was produced, to specification, for the latter division and a gas volugraph, for carbonate analysis, was constructed for the Chemistry Division.

Five rotary fusion burners, for uranium sample preparation, were built, two of which were sold outside the Council. The device, designed elsewhere, was modified and improved by Council staff. This modification has created sufficient interest that the improved version was advertised for sale in a

technical journal. Finally, a descriptive brochure has been prepared.

Interest in the SRC water level recorder remained high. Several more recorders were sold during the year. These sales involved very little additional construction time because most of the plastic components had been mass produced previously. A major modification of such a recorder was undertaken for a contract with a consulting engineer. This change involved converting the recorder into a recording piezometer for groundwater pressure measurements. The unit was installed by Council staff in a mountainous area of B.C. and two more units have been ordered. A specialized pipe joint tester also was constructed for this project and sold to the consultant.

A second gas volugraph for carbonate analysis was constructed and sold to a mining farm. Finally, a number of small construction jobs were completed including a sample controller for the Physics Department of the University of Saskatchewan and the building of 20 special recorder clocks for water level recorders.

Precipitation Physics

Seeding of clouds to modify weather is proceeding actively near Saskatchewan's western and southern borders, commonly using silver iodide. Upon occasion, "extra area" (in contrast to "target area") effects have been produced by cloud seeding. In order to study the implication of possible transboundary migration of these weather modification chemicals, the Physics Division (under Subvention to the Atmospheric Environment Service, Environment Canada) has initiated a study to assess the airborne silver iodide budget within this Province. The study was conducted during the summer months, when cloud seeding activity is at its peak.

Amounts of silver in the air, water and biota are being monitored on a province-wide basis, and techniques have been developed to monitor silver in the air on a routine basis down to 5×10^{-13} grams per litre. This year, stations were established at Alsask and Saskatoon while future expansion of this program will take place in the southeastern sectors of the Province.

Winter measurements of snow and ice crystal electrification continued this year. Currently, an extension of this project is being planned whereby ice crystal morphology and microphysics will be studied in more detail. A joint SRC - Hokkaido University (Japan) research expedition is planned for the coming year. Air temperature regimes, ice crystal shapes and sizes, as well as number densities will be studied intensively at North Battleford and Inuvik (N.W.T.). Hopefully, comparisons of the parameters will lead to a better understanding of the ice fog phenomenon, which is such a persistent feature of the Saskatchewan winter environment.

Information Management Systems

The main emphasis in the area of geophysics has involved investigations and use of computer-assisted methods of handling, storage, retrieval and analysis of large quantities of analytical, geophysical and coal seam information. Of course, this emphasis was related to the lignite coal resources evaluation program detailed under Lignite Resource Data Analysis. For this work, bibliographic data on about 1,250 selected references were coded and entered into a commercially available, computer-assisted, retrieval system called FAMULUS. The objective of this work included building a resource library on the subject of coal, with special attention to the geographic region of Saskatchewan.

Some work is underway on building a computer processable file of hydraulic-head information. This work is undertaken in cooperation with the Geology Division. During the year, related work was undertaken jointly between the Geology and Physics Divisions and in consultation with the Graphic System Design and Application Group of the University of Saskatchewan. This work concerned a computer assisted procedure used to handle piezometer data for groundwater studies.

All computer procedures are run on computer facilities owned and operated by the Saskatchewan Computer Utility Corporation, SASKCOMP. Large jobs are run on an IBM 370/158 computer using programs written in COBOL and FORTRAN. For smaller jobs, use is made of a Hewlett-Packard 2000F computer with programs written in time shared BASIC. Access to this computer is by telephone line from a small terminal.

Instrumentation Graphics

The purpose of this project is to complete and formalize the description and specifications of equipment designed and built mainly by the Physics Division. This work is in aid of other programs dependent on the equipment and helps investigate the marketability of this equipment. Some instruments are used regularly and therefore require "user" and "maintenance" documentation. Other devices have general applications and require "technical" and "specifications" documentation. This project produces documentation in the form of technical drawings, photographs and reports. Specialized emphasis is placed on standardization of the documentation procedure and products.

This year, documentation was completed on the data tablet digitizer system, the data translater system, and a method of digitizing graphical curve-traces. In addition, a brochure was completed which described the specifications of an SRC built "sample fusion rotary burner for use in fluorimetric uranium analysis", a device manufactured to order by the SRC.

Lignite Resource Data Analyses

The joint federal-provincial lignite coal resources evaluation program in Saskatchewan, which began in 1971, has now reached an advanced stage, in terms of data compilation and cross-correlation. The main purpose to date, of the Physics Division's part of the program, has been to process the results of the analytic work and to build an information file of these data on magnetic tape. As of May 1976, analytic information concerning 4,552 samples from 490 drill hole sites in Saskatchewan was on file.

The cooperative resources evaluation program designed to obtain and correlate chemical, geophysical, and geological data involves the Canada Department of Energy, Mines and Resources (EM&R), the Saskatchewan Department of Mineral Resources (DMR) and the SRC.

Some 38,000 chemical data items have been reported on the analytical file. In June, a report was completed defining 22 self-consistency tests for the analytic data. Presently, EM&R personnel are checking those cases (i.e. about 3,400 data items) which failed the self-consistency tests. A large effort was directed toward creating a certified database residing on magnetic tape. The computer assisted procedures for maintaining the file were well proven and computer processing of information was rapid, efficient and economical. The greatest amount of time was spent preparing and checking chemical and geographic data at control points along the data processing route.

Work has continued on data processing to construct a file of borehole geophysical information residing on magnetic tape. As of June 1976, a total of 2,179 geophysical logs from 440 sites in Saskatchewan had been digitized. The main geophysical information includes density, gamma ray, and caliper measurements recorded at each site. The objective has been to digitize the graphically-recorded curve-traces and to report these digitized data on magnetic tape. The purpose of the file of digitized geophysical information is to help correlate the chemical with the geological information at each site and thereby assist the coal resources inventory.

Work is currently underway to "align" the sample-interval data from the analytical file with the geophysical borehole data. The purpose of this alignment is to adjust the position of the coal samples to the correct depth, with respect to the geophysical data, so that accurate cross-correlations can be made between chemical data, geophysical data, and specific coal seams.

In addition, work is currently underway to compute selected statistics based on information mainly in the chemical file and related to specific coal seams.

Air Pollution Abatement

Laboratory and field sampling capability, in this general area, was increased considerably in the past year, with the purchase of direct particle sizing-by-sampling devices known as cascade impactors. In addition, a special dust free work area and fume hood was installed for microscopic and microphotographic work on particle samples.

During the year, investigations were carried out in several locations on specific problems. In each case, the work was undertaken for a particular client under the Council's contractual policy. The requirements might involve 1) mathematical analysis of plume diffusion and dispersion properties from stacks, 2) airborne concentration measurements taken on site, or 3) particle size analysis of previously collected samples of material.

Research continued on smoke plume tracking by electric field change monitoring on the ground. This probe technique appears highly promising for short range (out to 15-25 miles) location of air pollutant clouds, when isolated single stack emissions are involved. In order to calibrate the technique, signal values still have to be correlated with actual concentration amounts.

Related to air pollution abatement, a research contract was undertaken this year on a roller brush atomizer. Modern research has produced some very efficient yet highly viscous chemical pesticides. When field application is considered, the normal nozzle spraying technique breaks down. The roller brush atomizer has worked out extremely well in this regard and appears to be a promising device for field trial use.

However, more research seems to be needed on the roller liquid supply reservoir system, as well as the size and capacity of the roller-brush itself.

Cold Weather Technology

Bitterly cold, dry winters, coupled with a modest frequency of severely high winds, have created problems for this Province that are truly unique. For example, the Physics Division currently is searching for the cause of an abnormally high build-up of snow in the fresh air intake of the Education Building on the University of Saskatchewan Campus.

The horizontal advection of snow particles and a series of poor aerodynamic features of the building seem to be responsible for frequent blocking of the air intake. An array of anemometers positioned at various locations about the structure have indicated generation regimes that seem to channel the driftable snow particles directly into the air intake.

Hydraulic flume studies are being simultaneously carried out by the UofS Engineering Department. It is hoped the design of more aerodynamically sound structures will be the result in the future.

Publications

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Barnett, D. B., *Data Tablet Digitizer System*. SRC Report P 76-10.

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Maybank, J., Yoshida, K. and Grover, R., *Droplet Drift and Downwind Deposition from Aerially Applied Herbicide Sprays: Analysis of the 1973-1974 Aircraft Trials*. SRC Report P 75-14.

Maybank, J. and Shewchuk, S. R., *An Analysis of a Roller-Brush Spraying System*. SRC Report P 76-2.

Maybank, J., Yoshida, K., Shewchuk, S. R. and Grover, R., *Comparison of Swath Deposit and Drift Characteristics of Ground-Rig and Aircraft Herbicide Spray Systems*. SRC Report P 76-1.

Peters, M., Yoshida, K. and Wallace, K., *Determination of Dust Contamination Level in an Automotive Painting Shop*. SRC Report P 76-9 (Confidential).

Shewchuk, S. R., Wallace, K. W. and Peters, M., *Determination of Discharge Rates and Particle Size Distributions from a Sodium Sulphate Processing Plant*. SRC Report P 76-8 (Confidential).

Wallace, K. and Yoshida, K., *Determination of Dynamic Spread Factor of Water-Based 2, 4-D Droplets Impacting on Water-Sensitive Papers*. SRC Report P 76-6.

Yoshida, K., Wallace, K. and Peters, M., *Nozzle Performance Survey of Saskatchewan Farm Sprayers (1975 Crop Season)*. SRC Report P 76-3.

Yoshida, K., Shewchuk, S. R. and Wallace, K., *Drift Measurement of Aerially Applied Spray Formulations Target, Aeromines (R)*. SRC Report P 76-7 (Confidential).

PHYSICS

THE UNIVERSITY PROGRAM

SCHOLARSHIPS

The Government of the Province of Saskatchewan offers graduate research scholarships tenable at either the University of Saskatchewan or the University of Regina. The purposes of the awards are to assist graduate students to prepare for careers in scientific and industrial research and to create interest in the exploitation of Saskatchewan's resources and in techniques that will advance the development of the Province. The Council conducts the selection of the awards.

Awards valued at $5,000 for the year beginning October 1, 1976 were made to:

L. F. Kratt, Biology, University of Regina

J. W. Rowson, Chemistry, University of Regina

J. P. Thorpe, Plant Ecology, University of Saskatchewan.

GRANTS-IN-AID

Since its creation in 1947, the Saskatchewan Research Council has provided grants to University of Saskatchewan applicants for applied research in the sciences. Sixteen grants totalling approximately $82,000 were awarded in 1976 to applicants at both the University of Saskatchewan and the University of Regina.

It should be noted that, since the following reports are prepared approximately half way through the grant year, specific results are usually not available for reporting. Copies of all papers published in the literature and of all theses resulting from grants-in-aid support by the Saskatchewan Research Council are available at the Saskatchewan Research Council library.

UNIVERSITY OF REGINA

DEPARTMENT OF ENGINEERING

Effects of Microwave Irradiation on Grain and Oil Seeds

under the direction of
Professor P. Bhartia

The objectives of this research program are twofold, a) to investigate the possibility of germination enhancement of grain, oil and vegetable seeds using microwave irradiation, and thereby shortening the growing period required; b) to investigate the possibility of using microwave irradiation techniques for weed control.

Saskatchewan's economy is primarily agriculturally based and the province loses considerable income due to short growing seasons which deteriorate the quality of our products and affect production levels. Further, heavy losses are incurred due to weed infestation of grain, oil and vegetable seeds. These losses take the form of shipping dockage from the country elevator to the terminal elevator, the cost of waste transportation, the cost of cleaning grain at the terminal elevator and most of all, the loss in yield due to weed competition. These losses were estimated at about $600 million dollars for Canada and $5 billion for the U.S. in 1971 and despite the heavy use of chemical weed killers, the problem is not under control.

Previous research has shown germination enhancement and increase in crop yield effects for seeds passed through static electric and magnetic fields. This work attempts to investigate the effects of electromagnetic wave irradiation on various seed types. In the first phase of the program, wheat, barley, flax, rape and wild oat seeds were subject to microwave irradiation for varying time periods and the effects of irradiation studied. The results of this preliminary work indicate that microwave irradiation techniques may be used successfully to combat wild oats infestation of oil seeds. This result is significant since the maximum dockage occurs for oil seeds rather than grain, the figures being 9% and 2.5% respectively. Research is presently under progress for studying effects of variation of power levels and irradiation times and also the effects of infra-red irradiation.

Ms. J. Baron, a departmental assistant and Marion Lebell have been involved in the program with Ms. Lebell working full time on the project during the summer and part time thereafter. This research is carried on in cooperation and consultation with the staff of the Regina Research Station of Agriculture Canada in liaison with Dr. Husband of SRC.

UNIVERSITY OF SASKATCHEWAN

DEPARTMENT OF ANATOMY

Cholesterol Binding by Alfalfa Fibre

under the direction of
Professor S. Fedoroff

Previously, we observed that after feeding alfalfa to normal animals, the blood serum cholesterol levels decrease significantly. We showed a direct relationship between the amount of cholesterol administered and the amount of alfalfa required to maintain normal blood cholesterol levels. The objective of the research during the past year was to more precisely determine which fraction of alfalfa contains the principle that binds cholesterol. A procedure was developed to test for active fractions through feeding experiments. By this method, the effect of the test fraction is compared to the effect of whole alfalfa for its ability to keep blood cholesterol at a normal level in spite of increased cholesterol intake.

During the past year, using the above method, we completed the testing of alfalfa residue after exhaustive alcohol extraction. All the activity for binding cholesterol was in the residue.

In collaboration with Dr. B. P. Goplen and Dr. R. E. Howarth of Agriculture Canada in Saskatoon, we tried to compare the effects of alfalfa cultivars for low and high saponin concentration. This experiment had to be abandoned because we were unable to get the animals to eat the alfalfa cultivars.

In co-operation with Dr. E. Coxworth and Mr. J. A. Kernen, Saskatchewan Research Council, we are comparing the effects of alfalfa leaves to those of whole alfalfa plants. At present, these experiments are in progress.

The significance of this research is that if the active principle which binds cholesterol could be isolated, or at least considerably concentrated, it would be feasible to use it in humans as a blood cholesterol-lowering agent. Large quantities of alfalfa are grown in Saskatchewan. Consequently, alfalfa might be used as a cheap source of a preventive agent which could be incorporated into food, thus controlling at least one factor (cholesterol) which plays a major role in coronary heart disease.

DEPARTMENT OF CHEMISTRY AND CHEMICAL ENGINEERING

Production of Sugar and Protein from Aspen Chips and Fibre

under the direction of
Professor D. G. Macdonald.

This project was initiated to study the feasibility of using Aspen Poplar fibre as a substrate for cellulose degrading microorganisms such as Trichoderma viride and Aspergillus niger. These organisms produce enzymes which break down the cellulose to sugars which in turn can be used to produce organisms having a high protein content suitable for either food or feed. There is a large supply of Aspen in Saskatchewan, as well as the rest of Canada and at present is not being utilized to any extent.

Mr. S. Kulbida, a chemical technologist and Dr. D. G. Macdonald, a biochemical engineer, in cooperation with Dr. E. Coxworth of the Saskatchewan Research Council have been attempting to grow the above organisms on Aspen fibre which has been steam treated. Although the organisms grow well on a sugar based substrate, growth rates are very low on the steam treated fibre. The low growth rates appear to be due to the lack of production of enzymes which attack the cellulose to produce sugars. Due to this deficit, we have used a commercial enzyme to determine if the fibre is degradeable. We have found that high yields of sugar can be produced from the steamed Aspen and so should be a suitable substrate for the organisms. However, unsteamed Aspen does not yield significant amounts of sugar and so would be a very poor substrate.

Efforts are continuing in the search for organisms which can grow on Aspen fibre to produce high yields of sugar and/or protein.

Oxidized Lignite Coal as a Pipeline Additive.

under the direction of
Professor C. A. Shook
Assistant: Mr. J. Nurkowski.

Leonardite, a naturally-occurring oxidized form of lignite coal, has been shown in previous studies to be a useful additive in preparing oil well drilling fluids. This project was intended to examine the use of Leonardite as an additive to slurries of various Western Canadian coals. The purpose of the additive would be to reduce the energy consumption of pipelines transporting these coals in slurry form.

During the present year, we have investigated the effect of Leonardite, alone and in combination with chemical additives, upon the viscosity of these coal slurries. Viscosity is an important measure of the energy consumption of a slurry for pipeline transport. Samples of Leonardite and the other coals were obtained with the assistance of the staff of the Engineering Division of the SRC. The results of these preliminary studies have been very encouraging. Significant reductions in slurry viscosity have been achieved at addition levels which would be economically justified in pipeline operation.

However, no pipeline verifications of this effect have been done. If pipeline tests confirm the effect, a market for pipeline additives prepared from Leonardite can be presumed. The slurry pipeline research facilities of the SRC are admirably suited for such tests and a program of investigation will be proposed.

DEPARTMENT OF CIVIL ENGINEERING

Design Considerations for Swelling Clays

under the direction of
Professor D. G. Fredlund.

Large portions of Saskatchewan have surficial soils that consist of highly plastic clays that undergo substantial volume changes due to environmental changes. The resulting volume changes result in distress to existing engineering structures.

The objectives of our research program are as follows:

1. The development of analytical procedures for the prediction of heave below light structures. The theory has been developed and at present

case histories are being used to ascertain the reliability of the predictive procedure.

2. The prediction of the safety factor of cuts and fills in swelling soils. The Belle Plaine overpass has been used as a case history which has been analysed in detail (Mr. A. Widger wrote his M.Sc. thesis on this topic).
3. The development of means for measuring *in situ* negative water pressures. (Mr. K. Bocking is just completing his M.Sc. thesis on this subject).

In addition, a complete summary and statistical analysis has been conducted on the properties of the soil underlying the city of Regina. Mr. B. Cheng (undergraduate engineer) received the cooperation of two consulting engineering firms in Regina in doing this project.

Publications

Fredlund, D. G., *Engineering Properties of Expansive Clays*. Presented to the Seminar on Shallow Foundations on Expansive Clays, Regina, October 27 and 28, 1975.

Fredlund, D. G., *Prediction of Heave in Unsaturated Soils*. Presented to the Fifth Regional Conference, Bangalore, India, 1975.

Fredlund, D. G., *A Diffused Air Volume Indicator for Unsaturated Soils*. Canadian Geotechnical Journal, Vol. 12 No. 2, pp. 213-223.

Fredlund, D. G., *Density and Compressibility Characteristics of Air Water Mixtures*. Canadian Geotechnical Journal, Vol. 13, No. 4.

Fredlund, D. G. and Morgenstern, N. R., *Constitutive Relations for Volume Change in Unsaturated Soils*. Canadian Geotechnical Journal, Vol. 13, No. 3.

Widger, R. A., and Fredlund, D. G., *Stability of Swelling Clay Embankments*. Presented to the 29th Canadian Geotechnical Conference, Vancouver.

Fredlund, D. G. and Morgenstern, N. R., *Stress State Variables for Unsaturated Soils*. ASCE Journal of Soil Mech. and Fdtn. Eng. (In Print).

Slope Stability in Cretaceous and Tertiary Bedrock Formations

under the direction of
Professor J. Krahn.

Slope instability along the major river valleys in Saskatchewan has been a major problem in the construction of civil engineering structures and in the land development along these rivers for some time. We at the University of Saskatchewan are studying the behavior of these slides with the hope that the study will lead to a measure of confidence in predicting the behaviour of these land slides and thereby reduce the problems associated with them. Presently, Mr. R. Johnson is working on his M.Sc. in this area. Analytical methods for slope stability analysis are being developed in conjunction with this program. Two papers have been published on this subject this past year which are:

Krahn, J. and Fredlund, D. G., *Evaluation of the University of Saskatchewan Slope Stability Program*. Soil and Materials Workshop Proceedings, Annual Conference of the Roads and Transportation Association of Canada, Quebec City, pp. 45-49.

Fredlund, D. G. and Krahn, J., *Comparison of Slope Stability Methods of Analysis*. Proceedings, 29th Annual Canadian Geotechnical Conference, Vancouver.

Measurement of Pollution from Agricultural Areas

under the direction of
Professor T. H. Lackie

This study is designed to check the feasibility of utilizing remote sensing techniques to detect and measure pollution from agricultural areas. If it can be proven that these results are compatible with results obtained by "ground truth" methods, then the limitations of "ground truth" methods may be overcome. This technique is of particular importance in Saskatchewan, where extensive areas must be checked, and where some of the areas are not easily accessible by roads.

Preliminary work was carried out during the summer of 1975. This work included a literature search and evaluation of film-filter combinations, and some preliminary flights over a local feedlot. During the summer of 1976, aerial photographs were taken over: the Pheasant Creek study area of SRC; the large scale feedlot at Hughton; and areas that potentially would be affected by runoff from holding ponds and salt piles associated with potash mines. The photographs obtained will be examined for any changes in vegetation, etc., due to pollution. Part of this examination will be carried out utilizing a density slicer which has a high degree of sensitivity.

The next stage will be to arrange aerial photography during the runoff period in the spring of 1977; and to check correlation with the ground truth data obtained by SRC personnel.

The Engineering Geology of Landslides In Southern Saskatchewan

under the direction of
Professor E. K. Sauer

Landslides are a widespread problem to the development of Southern Saskatchewan. Roads, bridges, dams urban development and open pit mining are affected critically by this problem. Highly sophisticated materials testing techniques and computer analysis methods are available for predicting the risk of slope movements and correc-

ting slope failures. However, the most important inputs are geological factors because they define the boundaries and nature of the problem. Unfortunately, very little is known about geological inputs as they relate to landslides in this province. In order to establish the significance of these factors, existing landslides have to be studied in order to establish the validity of analytical techniques and how geological factors affect the theoretical aspects to the problem.

Two projects were completed in 1976. The first completed an analysis of slides on the South Saskatchewan River bank at Beaver Creek. The results of this study establish a framework for all future development along the river from the University to a point about 13 miles south. This project was part of a Masters degree program from M. D. Haug, presently on staff at the University.

The second project completed the geology of a large landslide in the Qu'Appelle Valley at the Fishing Lakes. The test drilling was supervised by Dr. E. A. Christiansen of the Saskatchewan Research Council. The geology was interpreted by Dr. Christiansen.

Publications

Haug, M. D., Sauer, E. K. and Fredlund, D. G., *Retrogressive Slope Failures Near Saskatoon, Saskatchewan*, Proceedings 29 Canadian Geotechnical Conference Vancouver, B.C.

Summary Report — Snow Drifting Study

under the direction of
Professor J. M. Wigham.

A research program was begun in 1976, to develop a facility and test procedures for simulating snow accumulation patterns on natural watersheds, as well as to model snow movement and drifting on and around buildings and other structures. The modelling involves using a flume in which the flow of water and fine sand simulates wind and snow movements respectively. Similar facilities do exist and have proven successful. However, none are in Western Canada, an area which has some unique snow accumulation and snow movement problems.

The initial phases of the project have been completed which included a literature search and a preliminary design for a recirculating flume. Some testing is in progress using an existing flume and sand supply apparatus. Results of these tests will be used to determine the flow characteristics which define model scales and to verify some of the theory. The tests are expected to provide a simulation of snow drifting problems which have been observed for a building in Saskatoon and for an airport hangar. Methods of alleviating the problems will be tested. Dr. G. Lakshman of the Saskatchewan Research Council suggested the two problems for study and has been instrumental in initiating various phases of the project.

The potential benefits of predicting snow accumulation and testing of procedures to alleviate it are great as model costs are low compared to continuous snow removal or other remedial measures.

DEPARTMENT OF CROP SCIENCE

Effect of Fall vs. Spring Seeding of Pulse Crops on Seed Yield

under the direction of
Professor A. E. Slinkard

The objective of this project was to compare the effect of late fall vs. spring seeding of peas, lentils and fababeans on stand, plant height, maturity date, seed yield and protein content. Four late fall dates of seeding of these pulse crops were made in 1975, starting October 1 and continuing every two weeks until mid-November. However, the mild fall of 1975 resulted in a warm damp seedbed which stimulated fall germination of the seeds and the seedlings winter-killed. Only a few lentil plants were evident in the spring of 1976 and this experiment was terminated. However, the cold dry fall of 1976 appeared conducive to late fall seeding and so a second experiment involving lentils and flax was initiated. Stand survival in the spring of 1977 will determine whether the experiment will be continued. If successful, the fall climatic parameters will be described with the assistance of Saskatchewan Research Council meteorological staff.

If late-fall seeding of lentils, peas, fababeans, flax and other crops could be perfected, the yield of these crops should increase by 15%. In addition, there would be a reduction in the heavy spring work load of the farmer trying to seed his entire farm in as short a time as possible.

DEPARTMENT OF GEOLOGICAL SCIENCES

Biostratigraphy of the Cretaceous White-Speckled Shales in Saskatchewan

under the direction of
Professor W. G. E. Caldwell.

The two Upper Cretaceous formations of white-speckled shales, that are widespread throughout the southern half of the province, have been extensively used as markers in stratigraphic and structural analyses. Yet their stratigraphy has been much misunderstood, with the result that many of these analyses are incorrect and invalid. The objective of the study has been to resolve the stratigraphy of these formations by using conventional biostratigraphic methods.

Lithologically, the white-speckled shale formations are readily confused; where their relationship is not evident from superposition, they can be distinguished only by their contained fossil faunas. The study has demonstrated that, at least throughout the median belt of the province, the formations are separated by a disconformity and, over much of this belt, are directly superimposed. A means of separating the shales biostratigraphically has been established. Their faunas have been correlated with the faunas of homotaxial equivalents in adjacent regions, and their regional stratigraphic pattern is now clear. As a result, structural relationships in parts of the province must be reassessed and revised.

The white-speckled shale formations are important economically. They have served as markers in exploratory investigations for groundwater conducted by members of the Geology Division of the Saskatchewan Research Council; in some parts of the plains the formations are known to be oil-shales; in other parts the formations may be the host rocks of uranium concentrations and are known to contain small oil pools.

Professional Research Associate, B. R. North and Graduate student, R. L. McKellar have been involved in the study. A joint paper describing the stratigraphy of the formations in Saskatchewan is in preparation. A paper describing, in part, the regional relationships of the formations has been accepted for publication.

Publications

North, B. R. and Caldwell, W. G. E., 1975. *Cretaceous Foraminifera from Saskatchewan and Manitoba*. Geol. Survey Canada, Paper 74-38, 35 p., 12 pls.

Caldwell, W. G. E., North, B. R., Stelck, C. R., and Wall, J. H., *A Foraminiferal Zonal Scheme for the Cretaceous System in the Interior Plains of Canada*. In Biostratigraphic Studies in Western and Northern Canada, Geol. Assoc. Canada, Spec. Paper 18 (in press).

Development of Seismic Reflection Methods for Subsurface Mapping in the Precambrian Shield

under the direction of
Professors Z. Hajnal and M. R. Stauffer.

The study described here has been undertaken in an attempt to develop the seismic reflection method as a tool for mapping subsurface structures in the complex rocks of the Precambrian Shield and aiding in prospecting for deeply-buried ore bodies. This project can be divided into two phases: a) developing techniques for obtaining reflections in geologically well-understood rocks, and b) utilizing the techniques in a poorly-understood region or to help in prospecting for an ore body. The first phase is about half completed. In the shield rocks near Flin Flon, Manitoba, reflections have been obtained from a fault zone, a stratigraphic contact, and from the horizon containing the Flin Flon ore body. Also, we have identified a near-surface reduction in seismic velocity caused by open fractures in the rock, and have designed shot-hole patterns, seismic-line arrays, and analytical methods that result in significant improvement in the identification of reflective horizons.

Analyses of synthetic seismograms made from the sonic log for the 10,000 ft. deep JXWS hole, drilled in the Reynard Lake pluton near Flin Flon, indicates that the three-dimensional shape of this body probably can be mapped.

Considerable work has yet to be done to complete the first phase of the project particularly: a) the determination of the most efficient shot-hole pattern, shot-hole depth, and explosive charge combinations; b) the best geophone arrangement; and c) the most suitable part of the energy spectrum to use.

A paper describing the work done to date was given at the AIME annual meeting, February 22, 1976, and has been accepted for publication in the SME TRANSACTIONS quarterly.

Publications

Hajnal, A. and Stauffer, Mel R., 1975. *The Application of Seismic Reflection Techniques for Subsurface Mapping in the Precambrian Shield near Flin Flon, Manitoba*. Can. Jour. Earth Sci., v. 12, n. 12, pp. 2036-2047.

Geology of the Alwinsal No. 2 Potash Shaft

under the direction of
Professor W. K. Braun and others.

One of the many scientific benefits of the growing potash industry in Saskatchewan has been that the sinking of numerous mine-shafts in an ENE-WSW line across the median belt of the Province has provided a series of continuous stratigraphic sections through the sedimentary sequence, from grass roots to the Middle Devonian Series, deep in the subsurface. Already the information, obtained from older shafts, has brought about important new interpretations of the biostratigraphy and lithostratigraphy of the Cretaceous and Devonian Systems. A detailed knowledge of stratigraphy is foundational to an intelligent search for mineral deposits. Consequently, every opportunity must be taken to study sedimentary sequences as they become available in new shafts.

Now, the second Alwinsal potash shaft has been sunk to levels in the lower part of the Upper Cretaceous Series. The sequence exposed in the shaft has been logged carefully, in detail. Numerous suites of samples have been collected and supplied to government agencies and univer-

sities for various kinds of detailed analysis. The rate of sinking of the shaft has been disappointingly slow. Hindrances resulted from labor problems at the mine site. As a result, it will take longer than anticipated to reach the Middle Devonian potash ore zone. Nonetheless, progress has been made in analysing the Upper Cretaceous samples obtained to date. These samples came mainly from the Lea Park Formation. The samples have yielded a sufficient number of molluscan and other fossils to establish the relative age of the beds. Consequently, preliminary assignments were made to established biostratigraphic zones. The work is not sufficiently far advanced as yet to draw any firm conclusions on regional stratigraphic relationships.

Graduate Student R. A. Watkins has been responsible for most of the sampling and for preparation of the lithologic log of the section.

DEPARTMENT OF HOME ECONOMICS

Modification of Field Pea Flour and Protein Concentrate

under the direction of
Professor A. K. Sumner.

Saskatchewan field pea (*Pisum sativum L.*) acreage has increased, from about 5,000 acres in 1972 to over 20,000 acres in 1976, under Provincial and Federal Government support and the incentive of a two million dollar mill constructed in Saskatoon by Pro-Star Mills Limited. Successful marketing of the mill's pea flour and protein concentrate may necessitate development of processing methods to modify properties in order to make them more competitive with well established soybean products.

This project was undertaken to expand the usage of pea flour and protein concentrate by developing methods for modifying the flavor, color and functional properties such as the nitrogen solubility index (NSI), water absorption, fat absorption and emulsification.

Small scale laboratory trials have been carried out using dry and moist heat under various conditions of time and pressure to modify the properties. Dry heat was relatively ineffective but moist heat, especially at 15 p.s.i.g., produced desirable changes in the properties. Most of the pea flavor could be removed. The NSI could be reduced from 88 to 13. Heat treatment of the flour and protein concentrate caused some browning as determined by the Hunterlab Color Meter.

Larger sized trials will be carried out in a modified autoclave prior to pilot plant trials. Other methods for modifying the properties will be investigated involving such methods as solvent extraction and extrusion.

Mr. J. A. Kernan, Saskatchewan Research Council provides liaison on this project and research is carried out by Mrs. Marilyn Nielsen, Research Assistant and Mrs. Janet Ness, Student Assistant.

DEPARTMENT OF VETERINARY PHYSIOLOGICAL SCIENCES

Adaptation of the Standard *In Vitro* Forage Digestibility Procedure for Improved Assessment of Unconventional Roughages of Potential Significance in Saskatchewan Livestock Feeding

under the direction of
Professors R. K. Chaplin, G. A. Jones
and J. F. Mathews.

The upgrading of low quality forages (e.g. straws and wood) continues to be of significant interest to the Saskatchewan Research Council and various faculty members of the University of Saskatchewan. Recently, a group called the Liaison Committee on Forage and Roughage Utilization was formed under the auspices of the Animal Production Research Centre to coordinate the activities of the increasing number of researchers who use the University's animal facilities to support their work on low quality forages. Measurement of the efficacy of the alternative forage processing methods is more cheaply and easily done by *in vitro* (outside the animal) techniques as compared *with in vivo* (animal digestibility trials) techniques. However, the standard *in vitro* procedures are inaccurate when used on the improved straws and wood.

During the past year, four significantly different *in vitro* procedures have been examined, in an attempt to improve the correlation between *in vitro* and *in vivo* results. Conditions within a single procedure such as; buffer: rumen fluid ratio, quantity of sample, anaerobiosis, specie of donor, and inoculum preparation also have been examined to improve the end result. The most promising changes appear to result from reducing the quantity of sample used in each digestion tube and in modifications to the preparation of the rumen fluid inoculum.

In most standard *in vitro* procedures, a final pepsin hydrolysis is carried out for 24 to 48 hours. This step is necessary when digesting standard feeds containing significant quantities of protein. Low quality forages, on the other hand, are very low in digestible protein. Results gathered during the past year indicate this step can be eliminated and in turn reduce the laboratory time consumed in the *in vitro* procedure.

We have been cooperating with Dr. E. M. Coxworth of the Saskatchewan Research Council on this investigation and related studies.

INSTITUTE OF SPACE AND ATMOSPHERIC STUDIES

Precipitation and Temperature of the Canadian Prairies as Predictable by Solar Activity.

under the direction of
Professor B. W. Currie

It has been known for many years that for some regions there is a relationship between solar activity, as indicated by sunspots, and precipitation and temperature. This relationship has been established beyond question by measurements on the width of the annual growth rings of trees in the south-western United States, the rings thicken for favourable combinations of rainfall and temperature. A comparable relationship apparently exists for the Canadian Prairies. Currie (*Climatic Trends on the Canadian Prairies*. Agricultural Institute Review, Jan.-Feb. 1954), related the annual precipitation and temperature for weather stations on our Prairies with records going back to about 1880 which showed above average values for years with a sunspot minima, and below average with sunspot maxima. The average sunspot cycle is about 11.5 years.

This apparent relationship between weather and solar activity is currently being investigated in other countries for several reasons. The most important is the possibility of predicting drouthy periods and the world productivity of food. Another is the possibility of discovering physical processes on the sun and in the space between sun and earth which could affect weather. The sunspots, as an indicator of solar activity, are associated with increases in the solar wind consisting of electrically-charged particles ejected from the sun, and in emissions of solar radio waves, x-rays and cosmic rays, all of which penetrate into our atmosphere. Changes in the amount of solar heat radiation are small, and are considered insufficient to affect weather. Still another is the International Magnetospheric Study (IMS) now in progress, which may explain how the aforementioned solar emissions can affect weather.

Our study has several objectives: confirmation that the relationship still persists for our Prairies by using more weather stations and up-to-date weather records; examination of the seasonal relationships; application of more powerful methods of searching for periodicities and their reliability; and examination, with respect to our Prairie weather, of other relationships more closely related to physical processes taking place in the atmosphere due to solar emissions. The last objective includes the atmospheric pressure at various levels in the atmosphere, the 27-day rotation period of the sun, and the so-called sectorial crossings related to the solar wind. The last activity is observed by spacecraft. The particles ejected from the sun drag solar magnetic field lines with them. Between surges of particles the magnetic field lines, at the so-called outer limits of our magnetosphere, reverse direction.

The relationship for our Prairies appears still to exist, although the correlation coefficients are small. If the relationship does exist, it should be more predominant for our Prairies, since the effect of solar particle emission occurs farther south over Canada than for any other country in the Northern Hemisphere. Extensive campaigns in Canada to study the physical processes will take place in our magnetosphere during the IMS. These include arrays of magnetometers, auroral photometers, and instrumented balloon and rocket flights. Their observations will be correlated with observations from spacecraft orbiting about the earth, and of various solar disturbances.

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McKenzie, C. T.	B.Sc.
Olm, O. J.	
Ostwald, W.	
Perkins, E. H.	
Pershyn, C. S.	
Peters, M. L.	
Quigley, D. P.	B.Sc.
Reich, R. D.	
Ross, W. H.	B.Sc.
Shewchuk, S. R.	B.Sc., M.Sc., Ph.D.
Sloman, I.	B.Sc.
Wallace, K.	B.Sc.
Yoshida, K.	B.Sc., Ph.D.

THE SASKATCHEWAN RESEARCH COUNCIL

FINANCIAL STATEMENT

Year Ended March 31, 1976

To the Directors of
The Saskatchewan Research Council

AUDITOR'S REPORT

Pursuant to Section 20 of The Research Council Act, being Chapter 406 Revised Statutes of Saskatchewan, 1965, I have examined the balance sheet of the Saskatchewan Research Council Fund as at March 31, 1976 and the statement of operations and operating surplus for the year then ended. My examination included a general review of the accounting procedures and such tests of accounting records and other supporting evidence as I considered necessary in the circumstances.

In my opinion, these financial statements present fairly the financial position of the Fund as at March 31, 1976 and the results of its operations for the year then ended, in accordance with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

Regina, Saskatchewan
August 6, 1976

W. G. LUTZ, C.A.,
Provincial Auditor

THE SASKATCHEWAN RESEARCH COUNCIL

NOTES TO FINANCIAL STATEMENTS

March 31, 1976

1. Accounting Policies:

Fixed Assets

(a) The Saskatchewan Research Council utilizes fund accounting wherein all receipts and expenditures including those for fixed assets appear in the statement of revenue and expenditures. To maintain accountability for fixed assets, it is necessary to record them as a balance sheet asset with a corresponding entry to "Equity in Fixed Assets". Because asset purchases and sales appear in the statement of revenue and expenditures, no provision has been made for depreciation on the fixed assets.

(b) The Council's policy is to remove the cost of all equipment from the accounts which have:

— become obsolete during the year
— been sold during the year
— been in service for ten years.

2. Unbilled Shareable Costs:

Under the terms of a four year agreement with the Federal Government Agency administering the Agricultural Rehabilitation Development Act, the Council has incurred expenditures of $170,200 on the Brackish Water Purification project during the period April 1, 1974 to March 31, 1976. The agreement allows the Council to recover from the Federal Government Agency, one-half of all eligible expenditures.

As at March 31, 1976 the Council had received all but $35,100 of the total $85,100 recoverable.

3. Commitments:

At the year end the Council is committed to purchase laboratory equipment in the amount of $52,000 to be paid over a five year period.

4. Employees Pension Fund:

The actuary of the Employees Pension Fund, stated in his report dated July 1975, that as at May 1, 1974 there was a deficiency in the Fund, in respect to past service benefits, of $88,613. In order to liquidate this deficiency the Saskatchewan Research Council must make fifteen annual instalments of at least $8,861 into the Fund.

The report also indicates that the Council's contributions for the cost of benefits in future years be at the rate of 139.81% of required employees contributions.

M121

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Statement 1

THE SASKATCHEWAN RESEARCH COUNCIL

BALANCE SHEET

March 31, 1976
(with comparative figures at March 31, 1975)

ASSETS

	1976	1975
Current:		
Cash	$ 57,458	$ 22,354
Guaranteed savings deposit	225,579	10,692
Marketable securities, at cost, which approximates market	20,000	—
Accounts receivable	421,592	242,561
Unbilled shareable costs (Note 2)	35,100	139,668
Prepaid expenses	32,338	21,170
Total current assets	$ 792,067	$ 436,445
Investments — Cost	$ 40,000	$ 60,000
Equity in Saskatoon Co-operative Association	$ 202	$ 201
Fixed — at cost		
Laboratory equipment	$ 733,122	$ 639,386
Automotive equipment	177,707	151,923
Building	81,000	81,000
Furniture and fixtures	122,285	106,632
Shop equipment	58,766	40,716
Land	10,000	10,000
	$1,182,880	$1,029,657
	$2,015,149	$1,526,303

LIABILITIES AND EQUITY

	1976	1975
Current:		
Accounts payable	$ 249,581	$ 155,135
Employee deductions payable	97,102	47,772
Deferred income	50,000	46,000
Total current liabilities	$ 396,683	$ 248,907
Equity:		
Equity in fixed assets (Statement 4)	$1,182,880	$1,029,657
Operating surplus (Statement 2)	435,586	247,739
	$1,618,466	$1,277,396
	$2,015,149	$1,526,303

(See accompanying notes to the financial statements)

Statement 2

THE SASKATCHEWAN RESEARCH COUNCIL

STATEMENT OF OPERATIONS AND OPERATING SURPLUS

Year Ended March 31, 1976
(with comparative figures for the year 1975)

	1976	1975
Revenue:		
Province of Saskatchewan		
— grants	$2,100,000	$1,600,000
— other grants, contracts and fees from industry	1,475,550	1,184,198
	$3,575,550	$2,784,198
Expenditures: (Statement 3)	3,325,424	2,826,218
Excess of revenue (expenditure) over expenditure (revenue) before the following	250,126	(42,020)
Other income	25,996	16,947
	$ 276,122	$ (25,073)
Research grants	88,275	108,850
Surplus (deficit) for the year	$ 187,847	$ (133,923)
Operating surplus, beginning of year	247,739	381,662
Operating surplus, end of year	$ 435,586	$ 247,739

(See accompanying notes to the financial statements)

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(See accompanying notes to the financial statements)

Statement 3

THE SASKATCHEWAN RESEARCH COUNCIL

STATEMENT OF EXPENDITURES

Year Ended March 31, 1976
(with comparative figures for the year 1975)

	Admin.	Chem.	Eng.	Geology	Industrial	Physics	1976 Total	1975 Total
Employee benefits	$ 27,461	$ 19,720	$ 34,444	$ 25,743	$ 12,920	$ 26,934	$ 147,222	$ 96,743
Fixed asset purchases	13,891	52,278	54,921	39,209	1,322	26,614	188,235	108,986
Other	78,877	19,530	49,800	49,877	20,708	21,311	240,103	254,773
Salaries	162,093	302,834	472,515	440,393	209,036	324,007	1,910,878	1,583,658
Supplies	17,356	23,156	58,506	47,496	32,345	26,959	205,818	178,975
Technical services	43,189	6,724	35,247	329,063	11,973	21,633	447,829	474,190
Travel and vehicle operation	11,019	8,629	33,604	93,526	21,305	17,256	185,339	128,893
	$353,886	$432,871	$739,037	$1,025,307	$309,609	$464,714	$3,325,424	$2,826,218

(See accompanying notes to the financial statements)

Statement 4

THE SASKATCHEWAN RESEARCH COUNCIL

STATEMENT OF EQUITY IN FIXED ASSETS

Year Ended March 31, 1976
(with comparative figures for the year 1975)

	1976	1975
Equity in fixed assets, beginning of year	$1,029,657	$ 998,306
ADD:		
Fixed asset additions (Statement 4)	188,235	108,986
	$1,217,892	$1,107,292
DEDUCT:		
Fixed asset disposals		
— written off (Note 1)	22,200	72,805
— sold	12,812	4,830
Equity in fixed assets, end of year	$1,182,880	$1,029,657

(See accompanying notes to the financial statements)

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(See accompanying notes to the financial statements)

LIST OF ABBREVIATIONS

DMR — Saskatchewan Department of Mineral Resources.

DREE — Department of Regional and Economic Expansion.

EM&R — Canada Department of Energy, Mines and Resources.

IMS — International Magnetospheric Study.

ISD — Industrial Services Division.

NRC — National Research Council.

NSI — Nitrogen Solubility Index.

NTS — National Topographic System.

PEP — Productivity Enhancement Project.

SDH&T — Saskatchewan Department of Highways and Transportation.

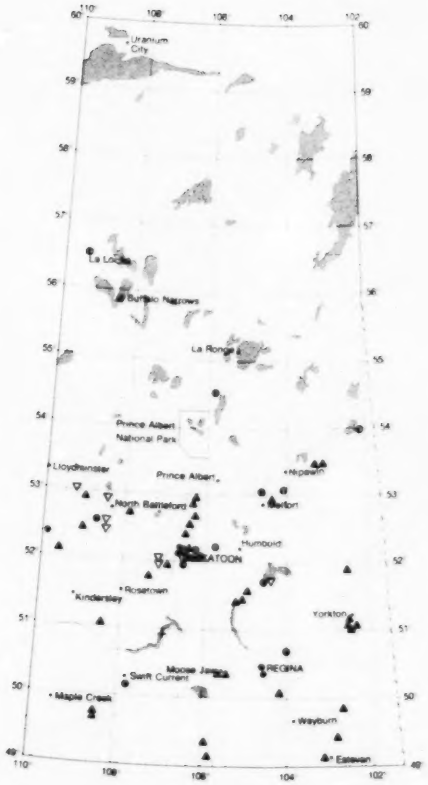
SPC — Saskatchewan Power Corporation.

SRC — Saskatchewan Research Council.

TIS — Technical Information Service.

UofS — University of Saskatchewan.

LOCATION OF SASKATCHEWAN RESEARCH COUNCIL FACILITIES



EXPLANATION

- ▲ Observation well
- ⊙ Sewer and water study
- • Pesticide sampling site
- ⊙ Spray freezing site
- • Slough study
- + Ice crossing study
- ▽ Watershed
- • Mineral recovery freeze desalination site